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RESIDENTIAL SUBDIVISION SERVICING AND DESIGN PRACTICES

Alberta
MUNICIPAL AFFAIRS
Innovative Housing Grants Program

RESIDENTIAL SUBDIVISION SERVICING AND DESIGN PRACTICES

August, 1986

Prepared By:

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The views and conclusions expressed and the recommendations made in this report are entirely those of the authors and should not be construed as expressing the opinions of Alberta Municipal Affairs.

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FOREWORD

The project documented in this report received funding under the Innovative Housing Grants Program of the Alberta Department of Housing. In May, 1986 the Alberta Department of Housing was amalgamated with Alberta Municipal Affairs which is now responsible for issuing this report.

The Innovative Housing Grants Program is intended to encourage and assist housing research and development which will reduce housing costs, improve the quality and performance of dwelling units and subdivisions, or increase the long term viability and competitiveness of Alberta's housing industry.

The Program offers assistance to builders, developers, consulting firms, professionals, industry groups, building products manufacturers, municipal governments, educational institutions, non-profit groups and individuals. At this time, priority areas for investigation include building design, construction technology, energy conservation, site and subdivision design, site servicing technology, residential building product development or improvement and information technology.

As the type of project and level of resources vary from applicant to applicant, the resulting documents are also varied. Comments and suggestions on this report are welcome. Please send comments or requests for further information to:

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EXECUTIVE SUMMARY

This report deals with residential subdivision design and servicing practices. The objective of the study is to examine those elements of subdivision design which have demonstrated potential for cost saving without affecting maintenance costs, and determining their applicability to development practices in the Province of Alberta.

Background to the subject is provided by a review of previous studies that have been carried out throughout Canada (Chapter One). Many of the ideas explored in these studies for more cost effective subdivision design and servicing appear desirable. Nevertheless, it is found that municipalities remain cautious in accepting modification to their standards because of fear of increased maintenance costs.

The study analyzes each element of subdivision design and the basic or generic principles involved in its design (Chapter Two). The specific requirements and design considerations are presented in terms of the subdivision element's primary function. The objective is to find better solutions to subdivision design which will produce the same or a higher level of service without an increase in costs.

Chapter Three examines the effect of modifications of traditional design methods by applying more appropriate standards on a typical parcel of land. Construction cost estimates are worked out and compared. Annual maintenance and operation costs for the two designs are also compared, using data obtained from three Alberta Municipalities.

The conclusion drawn from the analyses is that many of the ideas presented are indeed cost effective both in terms of capital construction and annual maintenance and operation. It then remains for municipal authorities to assess these elements in light of their own experience.

A tabular format is developed for the comparison of standards on an element-by-element basis for eight Alberta municipalities.

Forms depicting each subdivision element have been prepared. A separate booklet provides these forms which include the range of current standards, a brief analysis of possible cost-saving measures to consider, and a suggested standard. It is intended that these forms be reviewed and municipalities make an assessment of their position within the range. In this way they can judge whether to maintain their current standard or adopt a new standard on any of the elements described.

It is envisioned that this will be the beginning of an on-going process of information transfer which will, in the long term, benefit municipal authorities, the land development sector, and Alberta consumers.

INTRODUCTION

Objectives

This report documents the results of a study on residential subdivision servicing and related planning issues. The objectives of the study were:

1. to review the subdivision design and development practices of selected Alberta and other Canadian communities,

2. to identify subdivision design and development practices which are cost effective, provide satisfactory performance and are potentially acceptable to Alberta municipal authorities, and

3. to prepare a draft manual on subdivision design and development practices which facilitates a comparison and assessment of standards and practices in Alberta municipalities.

Study Approach and Results

The study was carried out in three phases generally corresponding to the study objectives and documented accordingly. The first phase reviews previous work on the subject, which includes a review of relevant studies and discussions with study authors on the impacts of those studies. The results of this phase are documented in Chapter One.

The primary focus of Chapter Two is to identify those elements of subdivision servicing where opportunities for cost savings appear and to develop summarized statements on the primary function and design criteria for each element. Where these design criteria are fairly extensive and/or specific, design solutions for the element under discussion are suggested. The results of this phase are summarized in Chapter Two of this report.

Chapter Three applied these ideas to a typical parcel of land and presents two subdivision designs; one using traditional design and the other adopting the ideas developed in the previous phase. Both subdivisions are compared on a capital construction cost basis for each element of work. Further, using annual cost data obtained from three Alberta municipalities, both subdivisions are compared on the basis of potential annual maintenance and operation costs for each of the major elements (Chapter Three).

An accompanying manual on subdivision servicing has been developed as a separate document. The overall goal of the manual is to facilitate a comparative review and assessment of servicing standards and practices in Alberta.

To accomplish this goal, the manual is designed to satisfy the following objectives:

1. to enable a quick review and comparison of servicing standards and practices in selected Alberta municipalities by servicing element,

2. to enable a comparison of these standards with those recommended in recent Canadian literature on the subject,

3. to present a brief analysis indicating the main design criteria and minimum requirements by element, and

4. to suggest a servicing standard by element.

Use of Report and Manual

This report is intended as a reference document which provides the rationale for the issues dealt with in this study and the basis for more cost effective standards. The manual is not intended to be a comprehensive treatise on subdivision design techniques and standards, but rather to begin a process whereby Municipalities and the development industry can exchange information on their current practices and ideas for long term improvement. Accordingly, its planned use involves circulation to municipalities and the development industry for their review and comment. Over time this manual will require updating and should expand in scope in response to changes in standards and practices.

Regulatory Authority

Readers should be aware that regulatory authority for different types of servicing elements resides, by statute, with various government Departments. These Departments and their jurisdiction are listed below:

Alberta Environment
Alberta Transportation
Alberta Labour
Alberta Energy and Natural Resources
Alberta Utilities and Telecommunications
Alberta Municipal Affairs

·CHAPTER· ONE·

LITERATURE REVIEW

INTRODUCTION

A review of current literature on subdivision servicing and design practices was carried out to provide background on the subject of this study.

The review of the studies is presented in the following manner:

a) A brief summary of the reports stating the purpose, scope, methodology employed and the major conclusions;

b) An assessment of the success of the reports by authors of the more significant studies. The authors were asked to comment on the acceptance of their study by municipalities, assess the success of the methodology employed, follow-up on the recommendations which have been implemented, and recommend a strategy for the implementation of the findings.

1.0 STUDIES REVIEWED

The following studies were examined for this report:

1. Urban Development Standards - A Demonstration of the Potential for Reducing Costs, Ontario Ministry of Housing, 1976, Page 5.

2. Urban Development Standards - A Detailed User Survey; Ontario Ministry of Housing, 1979, Page 8.

3. Comparative Subdivision Servicing Study - Cost Analysis of New Techniques, Paul Theil Associates Ltd., 1979, Page 10.

4. Residential Subdivision Development in British Columbia - Possibilities for Cost Savings, Willis, Cunliffe Tait & Company Ltd., 1977, Page 13.

5. Residential Services and Site Planning Standards; British Columbia Ministry of Municipal Affairs, 1980, Page 17.

6. Residential Subdivision Servicing Practices and Costs, Associated Engineering Services Ltd., 1983, Page 19, Unpublished.

7. City of Winnipeg, Review of Land Development Servicing Practices and Standards: The Potential for Cost Reductions, De Leuw Cather, Canada Ltd., 1977, Page 21.

8. Housing and Design Study (Part II) for New Town of Fort McMurray, Cohos, Evamy and Partners, 1975, Page 24.

9. Residential Streets, Objectives, Principles and Design Considerations, ULI, ASCE, NAHM, 1974, Page 26.

10. An Energy Efficient Land-Use Strategy for the City of Lethbridge, De Leuw Cather, Western Ltd., 1982, Page 28.

11. Sensitive Infill - Part I; Peter Barnard Associates, 1983, Page 30.

1. Urban Development Standards - A Demonstration of the Potential for Reducing Costs; Ontario Ministry of Housing, 1976

Purpose: To examine potential savings from improved standards in order to moderate housing costs.

Scope: Examination of typical development sites in urban centres in Ontario. Four designs were prepared, two using conventional practice and two using innovative planning and engineering standards.

Methodology: The study adopted a practical approach by examining four alternative designs for the same 50 acre parcel of land. One design was done with the existing conventional Ontario standard and one with the metropolitan Toronto standard. The same parcel was then re-designed with proposed innovative standards for Ontario, and again with proposed innovative standards for metropolitan Toronto. The "innovative" standards were developed to reduce capital costs and retain low maintenance and operating costs. The total costs for each design were calculated and compared to the prevailing standards to show the areas of significant cost savings.

Major Conclusions: Savings of up to $6000 per lot were projected using modified planning and engineering standards. The breakdown of potential savings indicated that reduced engineering standards accounted for 28% of the savings, while the planning and density factors accounted for 72%.

The proposed modifications to engineering standards were not extreme, and included such items as:

	Proposed	Prevailing
Sanitary Sewer:		
- Minimum size:	200 mm	250 mm
- Manhole Spacing:	170 m	91 m
Waterworks:		
- Minimum size:	150 mm	150 mm
- Minimum size on cul-de-sac:	100 mm	150 mm
- Length without looping:	40 units	N/A
- Valve spacing:	40 units	200 m
- Hydrant spacing:	150 m	120 m
Service Connections:	shared	individual
Storm Sewers:		
- Design Storm Frequency:	2 year	5 year
- Minimum pipe size:	250 mm	300 mm
- Manhole spacing:	170 m	91 m
- Catch basin spacing:	107 m	91 m
- Roof Leaders:	to ground	to sewer
- Foundation Drainage:	to ground	to sewer
Roads:		
- Minor Collector Right-of-Way:	20 m	20 m
- Minor Local Road:		
Right-of-Way:	15 m	20 m
Pavement Width:	8 m	8.5 m
- Cul-de-sac:		
Right-of-Way:	15 m	20 m
Pavement Width:	8 m	8.5 m

Assessment: The impact of the report was discussed at length with Mr. Keith Bain, Director of the Local Planning Policy Branch of the Ontario Ministry of Housing. The study recommendations were found to have very limited impact at the time of publication. However, more recently there has been more interest by municipalities in such cost-effective recommendations.

Changes in the economic climate in Ontario have made Municipalities more receptive to cost-saving measures.

The Ministry had considered making the standards mandatory but was met with stiff opposition from the municipalities. They also considered the idea of using "performance" specifications, but the municipalities argued that this would let the developer set the standard. There was also thought given to inducement by tying the standards to the existing grant system under which municipalities receive funds for sewage treatment plants and trunk sewers. This method has not yet been fully explored.

In 1979, the Ministry conducted a detailed user survey of municipalities which had accepted or were prepared to accept some of the report recommendations. A review of this user survey is given in the section which follows. The Ministry is also organizing a series of seminars with municipalities to discuss the report recommendations in more depth, which they feel will be successful.

The argument about possible increases in maintenance costs due to modified standards is still being used by municipalities to reject proposed changes to their standards. Because there is often no hard data available on maintenance costs, these arguments cannot be easily countered. The Ministry is therefore considering undertaking a comprehensive study of municipal operation and maintenance costs related to elements of servicing. To date this is only in the formative stage.

2. Urban Development Standards: A Detailed User Survey; Ontario Ministry of Housing, 1979.

Purpose: The purpose of this study was to determine the number of municipalities in Ontario which have accepted or were prepared to accept some of the recommendations made in the report "Urban Development Standards -A Demonstration of the Potential for Reducing Costs" published in 1976.

Scope: All municipalities in Ontario were sent a questionnaire to determine what planning and engineering standards were being used or planned for. Thirty-three replies were received and analyzed.

Major Conclusions:

a) Awareness of the concept of modified standards was high.

b) A majority of the responding municipalities were considering modification of some kind to their standards.

c) An estimate of approximately 4100 units built or under construction employed major reductions in site servicing standards.

d) Modifications to site planning standards were achieved mainly on a site by site basis rather than general amendments to by-laws.

e) Changes in engineering standards were being applied on a municipality-wide basis, rather than a site by site basis.

f) The use of "zero-lot line" concept was almost always used in conjunction with major reductions in lot size and lot width standards.

g) There was significant adoption of storm drainage systems similar to those proposed in the Urban Development Standards study.

h) Gradual acceptance of reduced road allowance widths for local roads had occurred, but these modifications were not judged significant in relation to the proposed changes.

i) The concept of "shared"* water and sanitary services in common trench was not widely used or accepted. Common trench was widely practiced to provide individual water and sanitary sewer services to each dwelling unit.

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* A "shared" service connection is where one service line is connected at the property line to two lines, each of which serves one dwelling. Common trench means that both a water and a sewer service line are placed in the same trench.

3. Comparative Subdivision Servicing Study - Cost Analysis of New Techniques; Paul Theil Associates Ltd., 1979

Purpose: The study was prepared for the HUDAC (now CHBA) Technical Research Committee to provide cost comparisons of new techniques versus conventional standards.

Scope: The study dealt specifically with considerations of sanitary sewers, storm sewers, watermains, service connections, roads and sidewalks.

Methodology: The study considered each element of servicing individually, giving the cost savings that could be effected by use of new standards and techniques over the "conventional standards". The conventional standards were taken from a survey of the standards currently used in 43 major centres across Canada. In some cases the unit costs of a single element were compared, while in other cases, such as storm drainage systems, the total costs of drainage systems for a prototypical subdivision were compared.

Major Conclusions:

Sanitary Sewers: Minimum 200 mm diameter was considered acceptable. Curvilinear sewers were also considered acceptable and increased manhole spacing to 150 metres.

Drainage: Design of minor systems for a 2-year return frequency was considered adequate. Storm sewers were designed for street flow only. Roof drains were discharged to the ground. Perimeter drains were discharged to the sanitary sewer. Where connection to

sanitary sewer was not allowed, use of a separate "third pipe" collection system for foundation drains was advocated. Catch basin spacing was increased to 150 metres.

Watermains: Use of PVC pipe was advocated; 300 metre spacing of valves and 300 metre spacing of hydrants was recommended. Use of 50 mm diameter watermains on short cul-de-sacs was advocated.

Service Connections: Shared services in common trench was advocated.

Recommended Local Street Widths:

17 metre right-of-way
8 metre pavement width for local streets
7 metre pavement width for cul-de-sacs
Use of two-stage curb construction

Use of all the above techniques could result in cost savings of 25% to 35% over conventional methods.

Assessment: The study was the most comprehensive of the reports reviewed and dealt with servicing items on an element-by-element basis. Cost comparisons were depicted both in tabular form and graphically. Discussions with Mr. Paul Thiel, P. Eng. revealed the following:

- Some of the recommendations in the report have been slowly accepted in the greater Toronto area. These have mainly been with the recommendations related to storm drainage and service connections.

- Although some municipalities have marginally decreased their right-of-way standards from 20 metres down to 19 or 18.5, the majority continue to use 20 metres as the standard.

- Shared service connections in common trench have been used extensively in recent years with no resultant increase in maintenance costs.

- Paul Theil Associates has designed over 10,000 lots utilizing a "three-pipe" foundation drain collector (FDC)* system and their analysis of costs from case studies shows a saving of $300 per metre in overall road construction costs.

- Mr. Theil's personal impression is that the likelihood of any report gaining wide acceptance in the short term is very small. However, municipalities may be more willing to listen or consider innovative proposals if a reference document is available which demonstrates the acceptability of value/effective servicing, considering both capital and maintenance costs.

- Mr. Theil advises that any effort in Alberta should probably refrain from detailing comprehensive standards and criteria, but merely suggest areas where cost savings have been proven and experience has not shown subsequent rise in maintenance and operation costs.

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* An FDC (or foundation drain collector) system involves the collection of basement sub-drains with a relatively small collector pipe which discharges at various locations in the sub-division to the nearest available watercourse, ditch or storm sewer.

4. Residential Subdivision Development in British Columbia - Site Services - Possibilities for Cost Savings; Willis, Cunliffe, Tait & Company Ltd., 1977.

Purpose: The study's stated objective was to determine minimum acceptable guidelines for residential servicing in British Columbia, considering both initial capital costs and continuing operating and maintenance costs.

Scope: The study was limited to consideration of the engineering aspects of providing subdivision services.

Methodology: The study was carried out under the guidance of a review committee which consisted of representatives from HUDAC, UDI, Union of BC Municipalities, Ministry of Lands, Parks and Housing, Public Works Association, and Municipal Engineers Division of APEBC.

The basic method adopted through the committee meetings was:

- to collect good ideas from all parties;
- to identify places where more economical methods were being practiced;
- to investigate the more economical methods and test their suitability;
- to disseminate the information on the methods which had proven successful in practice.

In conjunction with the above, a survey questionnaire was sent to all municipalities in the Province, as well as advertisements in newspapers and magazines soliciting comments on subdivision practices.

Major Conclusions: Savings could be realized in the following areas:

Sewage:

- Reduction in minimum pipe sizes and minimum gradients and allowing curvilinear sewers.
- Basing manhole spacing on the range of maintenance equipment available, which would often result in larger spacing.

Waterworks:

- No significant savings predicted if current fireflow requirements were maintained.

Roads:

- Savings can be realized by adopting a minimum right-of-way of 17 metres and a minimum pavement width of 8.5 metres.

Drainage:

- There are possibilities for cost savings by the use of more efficient stormwater management techniques.

No attempt was made to quantify cost savings as the authors took the position that: "widespread adoption of more economical practices which have been proven by experience must be beneficial and cost saving, and that these savings should be realized wherever possible".

Assessment: The report was comprehensive and honest in its appraisal of servicing standards. It did not present prototypical examples to express potential savings quantitatively. Discussions with the author of the Willis, Cunliffe, Tait report, Mr. Ray Le Noury, P. Eng. and Mr. Ken McCloud, Director of Research for the British Columbia Ministry of Municipal Affairs revealed the following:

- The report was accepted by HUDAC, and approximately 100 copies were distributed.
- Later investigations have shown the report has not had any significant impact on municipal standards.
- There has been no attempt at follow-up by wider distribution or informational seminars of any kind.
- The author's opinion is that in an inflationary market, changes to engineering standards do not have significant effect on the final cost to the homebuyer and therefore the argument for reduced standards is not viewed seriously.

The following are some of Mr. Le Noury's general comments on the study:

a) It is assumed that the "cost effective techniques" are deemed to be so if they benefit "the public", either the Municipality who have reduced maintenance costs or the eventual lot purchaser who buys the lot at a lesser price. In a sellers or "developers" market, there may be no direct relationship between the "cost of development" and the "sale price of lots" which is established by the marketplace. If in fact the margin between development costs and market price for the lot is large, the Municipality may be viewed as pursuing "cost effective techniques" by requiring very high standards as they are partially paid from the developers margin.

b) As the market softens, and lot prices fall, the margin between development cost and sale price is reduced. If the developer wishes to stay in business, and competition for available business increases, he looks at reducing costs and passing through at least some of the savings to the eventual lot purchaser. It is at this time that innovative design techniques, which reduce costs, may be cost effective to "the public", the lot buyer.

c) Generally, Municipal authorities have two roles in providing housing for the community:

   i) to plan and control land use so that sufficient land is available for housing;

   ii) to control development practices so that they are in conformance with the community's objectives.

   The latter involves setting of standards and codes to protect the home buyer and to ensure that elements which are subsequently handed over to the municipality are of good quality so that they require minimal maintenance.

d) If the Municipal authorities wish to reduce the cost of housing they must initially have policies which encourage the development of an abundance of lots for sale so that, within the constraints of the overall

economy, they allow a buyers' market. It may then be worthwhile to consider more economical development standards as they may be "cost effective" to the lot buyer.

5. Residential Services and Site Planning Standards; British Columbia Ministry of Municipal Affairs, 1980.

Purpose: To provide a set of recommended engineering and planning standards for British Columbia Municipalities.

Scope: The study covered both planning and engineering standards from a generic point of view. It did not attempt to develop cost saving techniques to any great extent.

Methodology: The study was evolved through an advisory committee which included numerous groups and associations (Association of Professional Engineers, Consulting Practice Committee and Municipal Engineers Division, British Columbia Hydro and Power Authority, British Columbia Telephone Company, British Columbia Roadbuilders Association, Canadian Manufacturer's Association, HUDAC, Planning Institute of British Columbia, Public Works Association of British Columbia, Union of British Columbia Municipalities and Urban Development Institute). The method used was to develop standards from basic principles combined with experience gained from the input of the various advisory committee members. These are then presented as "Recommended Development Standards" rather than Guidelines or Regulations.

Major Conclusions:

a) No concensus was arrived at as to what should be done with the recommended standards.

b) Implementation of the recommended planning standards can realize substantial cost savings, but implementation would be difficult because of local attitudes and traditions.

c) The possibility of significant cost savings by adoption of the recommended engineering standards was considered negligible.

d) Savings made through the adoption of the recommended standards would not necessarily be passed on to the homebuyer, particularly during inflationary market conditions.

e) Senior government regulations have a minor effect on residential development costs.

f) Notwithstanding the above, adoption of province-wide standards (which should allow for unique local conditions) was considered a worthwhile ultimate goal.

Assessment: Discussions with Mr. Ken McCloud, Director of Research, British Columbia Ministry of Municipal Affairs, revealed that although the study was endorsed by the advisory committee and received wide distribution to British Columbia municipalities, it has had little or no effect on reducing housing costs. No municipalities that he was aware of have changed their development standards as a result of their study.

The report has been accepted to some extent by smaller municipalities who previously had no standards, and they have adopted some of the recommendations in the report.

6. Residential Subdivision Servicing Practices and Costs; Associated Engineering Services Ltd. 1983 (Unpublished).

Purpose: The purpose of this study was to compare residential subdivision practices and costs in representative Alberta municipalities, to identify servicing techniques which offer opportunities for cost reductions, and identify those municipalities which have demonstrated a willingness to consider innovations.

Scope: The study examined planning and engineering standards and approval procedures in eight selected Alberta municipalities, including Calgary, Edmonton, Hinton, Sherwood Park, Fort McMurray, St. Albert, Red Deer and Lethbridge.

Methodology: The study presented a detailed comparison of approval procedures as well as planning and engineering standards for each of the eight municipalities. It examined the costs of serviced lots from the period 1973 to 1981. It also reviewed other studies on housing costs, such as the Ontario Ministry of Housing report. It provided descriptions of each municipality in terms of physical conditions, market pressures and development practices. Subsequently it examined the impact of standards on development costs and analyzed the effects of innovations.

Major Conclusions:

a) The impact of planning standards on subdivision costs was considered difficult to assess.

b) Housing mix policies were deemed to be inconsistent and inflexible, and detrimental to developers' attempts to provide housing types which the market demands.

c) Dedication for schools and parks should not exceed 10%.

d) Minimum lot sizes affected yields and therefore significantly impacted lot costs.

e) Road right-of-way widths also affected lot yields.

f) Servicing standards could affect lot costs; possible reductions of up to $4,000 per lot were predicted in some municipalities.

g) The most significant way to effect savings by modified standards was to increase lot yield.

Assessment: The data collection and comparison of standards used in the eight municipalities was comprehensive. However, the report was not published.

7. City of Winnipeg, Review of Land Development Servicing Practices and Standards: The Potential for Cost Reductions; De Leuw Cather, 1977

Purpose: To review current costs of servicing land, trace the relationship between servicing costs and rising house prices, over 1972-1977 period, and examine the potential

for servicing cost reductions by using modified servicing standards.

Scope: The study dealt strictly with the hard costs of waterworks, sewerage, drainage, streets and lanes and street lighting.

Methodology: A typical Winnipeg subdivision was chosen with an area of 27.5 gross hectares yielding 283 single-family lots, and a development cost estimate was generated based on the 1977 Winnipeg standards. From 1972 to 1977, development costs, cost of serviced lots, cost of housing and cost of house and lot were plotted and analyzed, with the following results:

Cost of Servicing	- 70% rise in 5 years
Cost of Serviced Lots	- 200% rise in 5 years
Cost of House	- 85% rise in 5 years
Cost of House and Lot	- 115% rise in 5 years

Servicing costs expressed as a percentage of the house price actually decreased by approximately 3% over the 5 year period, and expressed as a percentage of the serviced lot price, decreased by 11% from 1972 to 1977.

The study went on to discuss various methods for reducing servicing costs; which can be summarized as follows:

		Cost Savings for Each Element
1)	Waterworks Increased hydrant spacing, Reduced diameter on cul-de-sacs Increased valve spacing	12%
2)	Sanitary Sewers Increased manhole spacing Reduced minimum pipe size Use of one manhole at cul-de-sacs	9%
3)	Service Connections Use of double service connections in common trench	25%
4)	Drainage Reduced design storm to 2 year return Increased overland flow length Increased manhole spacing Use of catch basins without sumps Offset storm sewer from centreline	27%
5)	Streets Use of 230 mm granular base course and 75 mm asphatic pavement with 450 mm curb and gutter	23%
	OVERALL ESTIMATED POTENTIAL COST SAVING:	21%

Major Conclusions

a) It appeared possible to achieve savings in servicing using modified standards. This represented approximately 5.6% of the current lot prices. The authors were unsure that these savings could be passed on to the homebuyer.

b) Reduced right-of-way widths, although not analyzed, were felt to offer additional cost saving potential.

c) Greater potential for reduction of serviced lot costs was felt to lie in smaller lots with shorter serviced frontages.

Assessment

A discussion with Tim Stratton, P. Eng., manager of De Leuw Cather's Winnipeg office, revealed that the study was not generally accepted by the City officials. The reason for this was not very clear. In any case, the recommendations had not been acted upon.

Our observation is that the study was not comprehensive and the conclusions related to cost savings were not definitive. In an era of rising house prices, that appeared independent of servicing costs, the report did not demonstrate how the homebuyer or the municipality would benefit by the use of modified servicing standards.

8. Housing and Design Study - Part II for New Town of Fort McMurray; Cohos, Evamy and Partners, 1975

Purpose: The study was commissioned by the Fort McMurray Board of Administrators to deal with rapidly escalating housing costs.

Scope: The study dealt mostly with housing types and lot sizes and attempted to show that greater densities achieved by cluster housing can reduce housing costs and still be acceptable as single-family dwellings.

Methodology: The study first of all breaks down the costs of residential development by component, expressed as a percentage of the total cost, on a real case study of a 15 metre x 30 metre lot. The main areas of potential cost savings were indicated as follows:

Item	% of Total Development Cost	% Savings From Total Development Cost
Storm sewer manholes @ 76 metre spacing	0.16	
Storm sewer manholes @ 122 metre spacing	0.09	0.07
Fire hydrants @ 91 metre spacing	4.0	
Fire hydrants @ 122 metre spacing	2.9	1.1
Water valves @ 91 metre spacing	1.2	
Water valves @ 183 metre spacing	0.6	0.6
175 mm curb and gutter	4.3	
125 mm curb and gutter	3.9	0.4
10 metre paved street	9.8	
6.7 metre paved street	6.8	3.0
TOTAL OVERALL SAVINGS (PERCENTAGE)		5.17

The report then presented an analysis of the advantages and disadvantages of smaller lots, cluster housing etc.

Major Conclusions:

The report does not state any specific recommendations, but does refer the reader to a report by Paul Thiel Associates: "A New Approach to Engineering and Planning for Land Development", 1975. It includes as an Appendix, several tables from the Paul Theil report and suggests adoption of those standards as a starting point to lower cost housing.

Assessment: The report deals mainly with housing configurations and lot sizing and makes some suggestions for greater manhole spacing, hydrant spacing and narrower roads. There are no definitive conclusions or recommendations, and the report appears to be intended as a discussion paper.

9. Residential Streets: Objectives, Principles and Design Considerations; ULI, ASCE, NAHB, 1974.

Purpose: This is an American publication initiated by the NAHB Research Institute to identify optimum residential street design and construction standards and practices.

Scope: The report was not intended as a comprehensive design guide but focused on a number of significant considerations related to residential streets.

Methodology: The report traced the history of road development in the U.S. and demonstrated that many design standards are now based on tradition and do not take into account present residential lifestyles. It then analyzed various basic principles which should be applied to street design, including safety, design, construction, intersections, parking, pedestrian paths and landscaping.

Major Conclusions: The major conclusion of the study was that no overall country wide standard was achievable, nor desirable. The report suggested that streets should be analyzed individually for the specific use intended and designed accordingly. For local residential streets, a range of possible pavement widths could vary from 8 metres to 5 metres depending upon specific use. The report encouraged reduction of right-of-way widths and placement of utilities in easements, arguing that wide rights-of-way create loss of valuable land and increase the municipal maintenance costs.

Assessment: The report was deliberately written in a style which would not draw any hard conclusions. However, the treatment of the subject of residential streets was comprehensive, carried out with sensitivity and understanding. The conclusion was that each street has its own specific use characteristics and design variables such as road widths or gradients should be considered in each instance of design, and not lumped together with commercial, industrial, and major arterial road standards.

10. A Strategy for Energy Efficient Residential Land Use for the City of Lethbridge, De Leuw Cather, Western Ltd., 1983.

Purpose: To develop a strategy for energy efficiency in the City of Lethbridge and to set out the corresponding planning and design guidelines. Further, to provide information on "state of the art" housing technology for energy conservation.

Scope: The study was limited to energy considerations in land development and housing construction.

Methodology: The study carried out a review of the current situation in Lethbridge and then generated a series of criteria for land-use planning which could help conserve energy. It then examined present technology and construction methods for energy-efficient housing.

Major Conclusions:

In terms of planning standards, the major recommendations for energy efficiency were as follows:

a) Increase allowable overall densities
b) Encourage infilling and minimize sprawl
c) Minimize vehicle trip requirements and encourage public transit
d) Encourage greater mix of uses and discourage isolated commercial developments
e) Align streets for optimum solar gain, all other things being equal
f) Reduce road rights-of-way and pavement widths
g) Use energy-efficient street lighting

Assessment: The study was only recently published and has not been distributed for a long enough period to judge general reactions. Preliminary indications are that most recommendations will be looked upon favourably, and some major ones implemented.

11. Sensitive Infill - Phase I Report, Peter Barnard Associates, 1983.

Note: At the time of writing, this was an interim report, and the final report had not been published.

Purpose: To develop a methodology for comparing the feasibility of an infill development strategy versus new suburban development and to test this methodology in an actual case study in metropolitan Toronto.

Some Tentative Conclusions of the Phase I Report:

a) In most instances, on a total cost basis, infilling appears to be more economical than new suburban growth.

b) Development costs appear higher for infill than for raw land.

c) Infill is a lower cost alternative for the municipality.

d) Personal transportation costs are much lower for infill.

e) Current zoning regulations are perhaps the main deterrent to infill.

Assessment: This report is not complete and therefore all conclusions are tentative. It does however, explore an interesting facet of residential development. Because sprawl has been commonplace in virtually every city in Canada, the norm for development approvals has been the new suburban subdivision. Administratively and financially, both municipality and developer are inexperienced at considering and evaluating infill developments. This type of report should help to foster productive discussion on the subject and explore the possibilities and constraints to infill development.

2.0 SUMMARY OF FINDINGS

The methodology employed in virtually all these studies was to examine present "standards" over a wide range of municipalities. This was accomplished through some form of questionnaire which involved over 40 municipalities in British Columbia, 8 in Alberta, 1 in Manitoba, numerous municipalities in Ontario, and 43 cities across Canada.

The procedure then involved examination of each service facility in turn (water, sewer, etc.) with an assessment of where construction cost savings could be achieved without loss of service quality.

A paradox is evident in the first part of the procedure. While the authors conclude that "standards" vary considerably from municipality to municipality, most also attempt to describe an existing overall "standard" which could be changed in order to save money. The setting of subdivision standards is within a municipality's jurisdiction, so it is to be expected that standards will vary.

It appears that there are two approaches possible for a study of servicing standards on a Province-wide basis:

a) Propose an all-encompassing practical minimum standard for consideration; or

b) Determine the range of standards throughout the Province and suggest a standard that is considered "progressive".

From discussions with the authors who took part in the previous studies, it appears doubtful that the first approach would gain general acceptance. A start had been made on the second approach with the Associated Engineering study which compared 8 municipalities in Alberta.

A review of the conclusions of the previous studies yields the following observations:

a) Expressed as a percentage of total cost savings in subdivisions, it was found that increases in density of dwellings could account for as much as 70% of predicted savings, while modifications to utility and road standards could account for as much as 30% of predicted savings.

b) The greatest savings in waterworks resulted from considerations of increased hydrant spacing, fewer service connections and smaller line sizes on dead-end streets.

c) The greatest savings in sanitary sewers resulted from increased manhole spacings and fewer service connections.

d) The greatest savings in storm drains resulted from the elimination of roof and basement drains being fed to a piped system and using the minor/major drainage concept.

e) The greatest savings in roadways resulted from reduced right-of-way and pavement widths.

Interviews with the previous study authors indicated that there has been acceptance of some of the ideas by municipalities over the last several years. Generally these have been in the following areas:

a) smaller lots,

b) slightly narrower streets,

c) use of shared service connections, and

d) elimination of roof and basement drains to storm sewer.

Acceptance has generally been limited to the insistent developer dealing with a receptive municipality. In one instance the developer went so far as to promise the municipality a sum of money equivalent to the amount that would be saved by allowing use of the innovative standards. He was successful in the implementation and the municipality has not suffered increased maintenance costs.

The interviews also revealed some important observations on roles and attitudes:

a) The imposition of subdivision standards has traditionally been a Municipal government role and attempts by Provincial governments to impose standards have failed.

b) While municipal authorities react to capital cost savings with maternal benevolence, the responsibility for achieving capital savings rests with the developer (except where the municipality is the developer).

c) The main interest of municipal authorities lies in the reduction of operation and maintenance costs.

d) In the setting of subdivision standards, municipal authorities justifiably insist on being totally in the "driver's seat".

e) The most common objections to changes in standards are that: (i) cost savings are rarely passed on to the consumer and (ii) changes in standards result in increased maintenance costs.

f) The studies have not presented any solid rebuttals to either of these two arguments. During periods of rapid inflation, lot prices were rarely related to the cost of construction and to date no hard data has been systematically collected on operation and maintenance costs.

3.0 PROPOSED STUDY DEVELOPMENT

From the review and assessment of the previous reports on site servicing it is apparent that future studies should be directed at the Municipal authorities. Developers are already aware of the advantages of potential cost saving and need no further convincing. With the Municipal authority as the prospective audience, discussions on standards should be viewed in the perspective of operation and maintenance as well as capital construction.

The study format should involve the preparation of a comprehensive list of suggested standards for the areas of development practices in which cost savings are significant. These should be presented to municipalities through an effective communication and feedback process. Given time, incremental changes in municipal standards will probably occur.

This method has been traditionally used and has had some selective acceptance. The Ontario Ministry of Housing surveyed the changes that occurred since their original study on development standards was published. The results of this survey are summarized on Page 4.

The problem with this approach is that it does not recognize innovation itself as a dynamic procedure. Standards which today are considered innovative may not be in 10 years, and the whole procedure will have to be repeated. This can be overcome by preparing a reference document which will allow feedback and can be updated on an on-going basis.

The following recommendations are drawn from the literature review and the study objective, and will be applied in the subsequent parts of this study:

1. The objective will be to allow maximum flexibility for developers to reduce capital costs while ensuring municipalities can minimize operation and maintenance costs.

2. The results of the study carried out by Associated Engineering on eight Alberta Municipalities will be summarized to establish some ranges of standards.

3. The major cost saving recommendations of previous studies on subdivision development will be summarized.

4. Annual operation and maintenance costs will be examined with respect to the ideas presented.

5. A mechanism will be outlined by which Alberta municipalities can be made aware of their position in the range of current standards and thus enable them to make comparisons with the "innovative" standards presented.

6. Subdivision design practice will be examined on an element-by-element basis with a statement of primary function for each. A format will be developed to allow circulation of the information to municipalities, with provision for their evaluation of the information and their positions on possible modifications to their standards.

·CHAPTER·TWO·

SUBDIVISION ELEMENT ANALYSIS

INTRODUCTION

Certain subdivision design elements were identified in the literature review to have potential for cost savings. It is not intended to compare these on a dollar basis at this stage. The intent is rather to examine each of these elements in terms of its primary function and to assess the requirements necessary to make that element perform its stated purpose.

The method used is to define with a brief statement the main purpose of a particular element of subdivision servicing. This is followed by a discussion of the main design characteristics that would enable that element to achieve its primary function. Conclusions are then drawn on the minimum or desirable design requirements for that element.

This analysis should be viewed not as a critique of current practice, but rather as a "back to basics" assessment of what necessary services a residential subdivision requires to make it functional, attractive and relatively economical to maintain.

1.0 WATERWORKS

1.1 Piped System

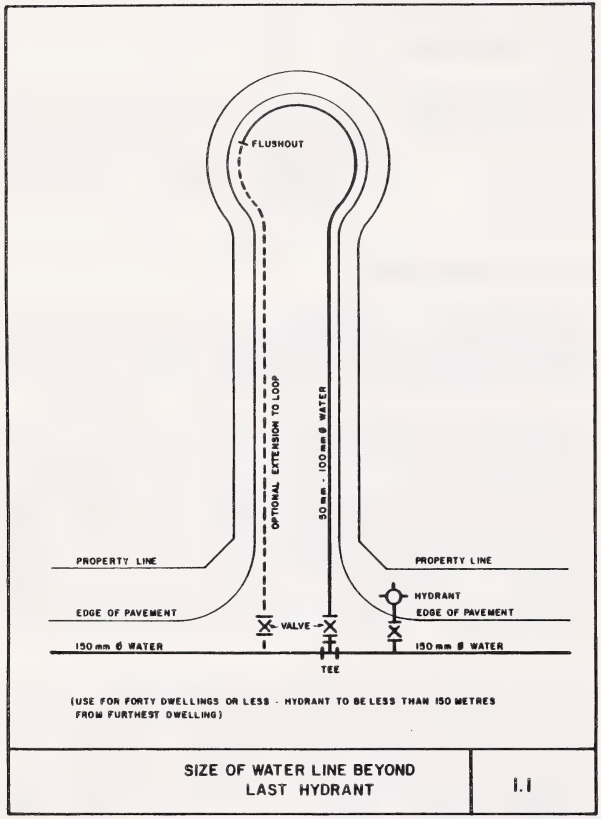
Primary Function: The piped waterworks network serves two purposes: to supply water for domestic use to each household, and to supply adequate water for firefighting.

Design Considerations:

The requirements to satisfy the above two functions are quite different. As a general rule, however, the flow and pressure requirements for firefighting within the normal size of subdivision are the dominant line sizing factor.

Consequently, until different firefighting techniques are developed, there can be very little scope for modification of the piped system. One area that has been identifed as having potential for pipe size reduction is in cul-de-sacs. In short cul-de-sacs where firefighting access can be gained from a hydrant placed at the entrance to the cul-de-sac, the requirement for the watermain can be safely reduced. The domestic requirements within a cul-de-sac can be easily satisfied with pipe sizes less than 150 mm diameter.

The criterion that should be used in assessing this is the length of the cul-de-sac, or the distance from the hydrant at the entrance, to the furthest house on the cul-de-sac. Since municipalities have different standards of firefighting equipment, each should set its own standard. Current equipment appears to have a reach varying from 100 to 150 metres.



SIZE OF WATER LINE BEYOND LAST HYDRANT | I.I

Depth of cover is another item that has been discussed in the literature. Freezing of watermains represents a significant operation and maintenance cost to municipalities and a major inconvenience to the homeowner. Freezing is generally overcome by placing the pipe below the frost zone. The typical problem with this method is that the frost zone is extremely variable, not only between regions, but also locally with a muncipality. In addition to ambient temperature, depth of frost is affected by local soil conditions and the amount of snow cover.

Geotechnical assessment of depth of frost should be carried out for individual subdivision proposals. Since geotechnical investigation is usually carried out to determine pipe bedding, pavement design and foundation requirements, it should not represent a significant expense to also assess the depth of frost. In regions where significant snow cover exists throughout the winter, savings in depth can be possible by placement of the watermains outside the paved area, in the boulevard or in an easement.

Suggested Standard

Minimum pipe size should remain at the current 150 mm diameter. Smaller pipe sizes can be used on cul-de-sacs, provided a hydrant is placed at the entrance and that the furthest house is not more than 100-150 metres from the hydrant, depending on local firefighting capability.

1.2 Hydrant Spacing

Primary Function: To provide water to firefighting vehicles.

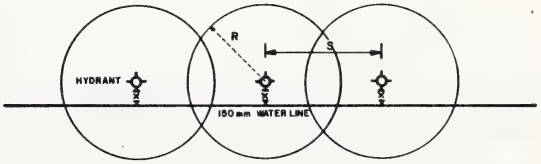
Design Considerations:

The spacing of hydrants has traditionally been determined by the available coverage for fighting fires at any home within the subdivision. In addition, a contingency procedure has prevailed by meeting the coverage requirements with any particular hydrant out of service. This effectively doubles the number of hydrants required. Current literature indicates that hydrant malfunction is rare enough to allow dropping the contingency of "doubling up".

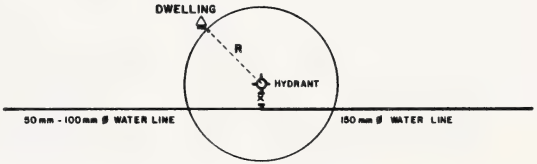
Suggested Standard:

It is suggested the Ontario Ministry of Housing Report guidelines be considered for adoption. These are:

- 150 metres from furthest housing unit
- 250 metres on line



HYDRANTS: On-Line Spacing



LAST HYDRANT: Distance to Furthest Dwelling

R = RADIUS OF INFLUENCE-TO REFLECT CURRENT FIRE-FIGHTING EQUIPMENT

S = ON-LINE SPACING (2 X R) LESS A NOMINAL OVERLAP

HYDRANT SPACING & DISTANCE	1.2

1.3 Line Valves

Primary Function: To isolate parts of the network for repair, testing or cleaning.

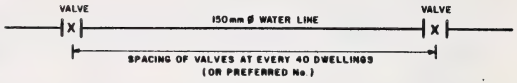
Design Considerations:

To achieve the stated function, valves should always be necessary at intersections. Typically these are 2 at a Tee-intersection and 3 at a Cross-intersection.

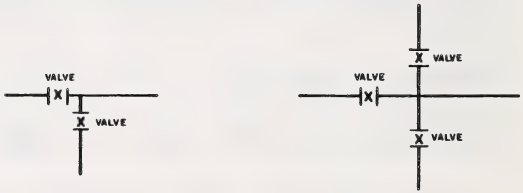
Valving along a line has typically been specified at a maximum length interval, varying from 150 to 250 metres. However, since the primary criterion for the line valve is the number of housing units put out of service by repairs, etc. and present lot frontages currently vary from 10 metres to 20 metres, it becomes more practical to specify a line interval in terms of housing units rather than a length. The Ontario Ministry of Housing Report suggests a maximum line valve spacing of 40 units. Obviously this can be a matter of choice for each municipality.

Suggested Standard:

Valve spacing should be specified in terms of housing units rather than length.



Line-Valve Spacing



Tee Intersection

Cross Intersection

LINE VALVES AND INTERSECTION VALVES | 1.3

1.4 Water House Service Connections

Primary Function: To supply adequate water to each home.

Design Considerations:

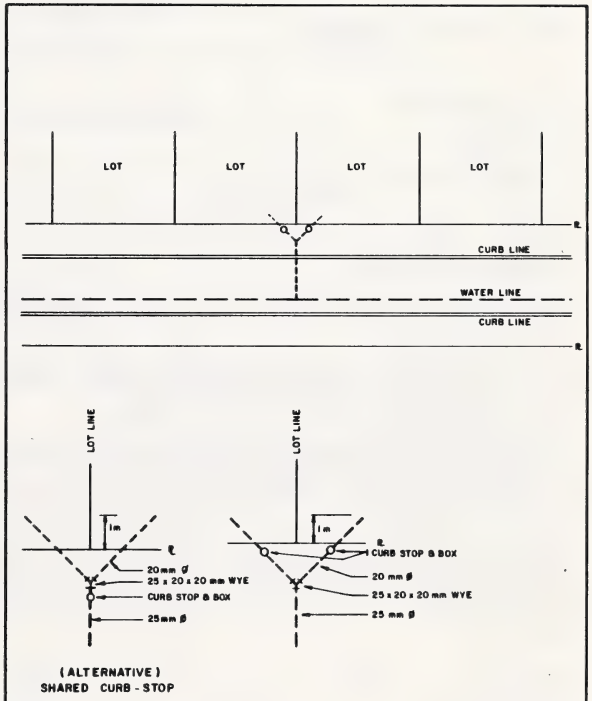
The normal size of a house service connection is 20 mm, while some municipalities request a 25 mm service. The area that has been identified as having potential for cost saving is in shared house service connections. These are depicted on Figure 1.4.

The main objection to this system is that if the part of the house connection which lies within the street right-of-way freezes, then two houses will be out of service instead of one. The other view is that since many connections freeze when the house is left vacant (vacations, etc.) the shared service connection would have less tendency to freeze, being used by the occupied house.

There has been discussion on the removal of the curb-stop on the house connection, as this presents a large maintenance cost during construction. Most municipal authorities feel this is impractical as it eliminates the opportunity to shut-off the service for repairs. A possibile option is the provision of one curb-stop for a shared connection.

Suggested Standard:

Consideration should be given to allowing shared water service connections. If properly designed and installed these may reduce long-term operation and maintenance costs.



SHARED WATER LINE HOUSE CONNECTIONS | 1.4

2.0 SANITARY SEWERS

2.1 Pipe Sizing

Primary Function: To convey domestic wastewater to disposal point.

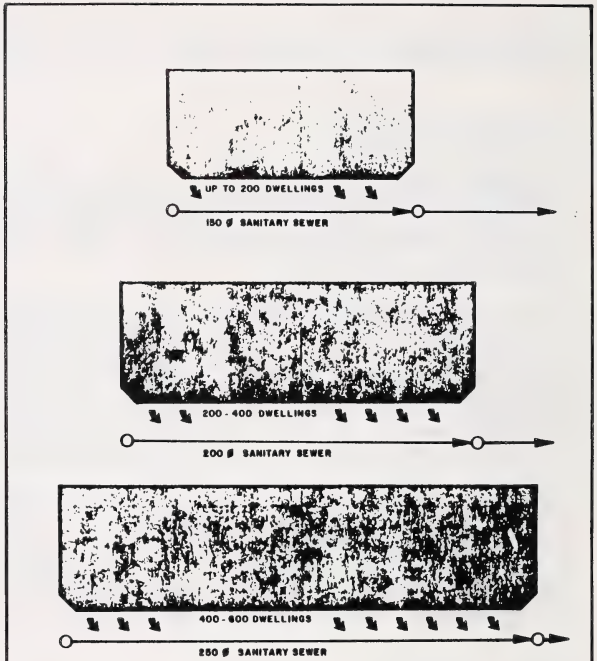
Design Considerations:

Municipalities generally set a minimum pipe size based on two considerations:

a) The pipe's capacity to carry the predicted flow.
b) The pipe's capacity to pass solids.

The first criteria is generally based on the Manning equation for hydraulic flow in conduits; a friction factor varying from 0.012 to 0.014 (average 0.013) is generally used in the design. The estimated domestic flow from dwelling units is normally taken as 1300 to 1800 litres per day (average 1500) and peak flow rate of 3 litres/minute. On this basis, pipes flowing full would have the following capacities (at a minimum self cleansing velocity of 0.6 m/s):

Pipe Size (diameter)	Flow	Equivalent Homes
100 mm	5 l/sec	96 homes
150 mm	12 l/sec	227 homes
200 mm	18 l/sec	360 homes
250 mm	31 l/sec	626 homes



MINIMUM PIPE SIZE FOR SANITARY SEWER — 2.1

The second criteria is related to the pipe's ability to pass solids. The normal toilet drain from a single family dwelling is 75 mm ϕ and is generally increased to 100 mm ϕ once it runs out of the house. It follows that a 150 mm ϕ pipe in the street is adequate to pass any solids that originate from the dwellings. Blockages have of course been recorded in all sizes of pipes. The literature review indicates that blockages have been due to three main reasons:

a) Intrusion of large solids from outside the home (eg. through manhole covers).

b) Intrusion of rags or other flexible material.

c) Deposition of solids due to low velocities and subsequent accumulation of smaller particles.

Alberta Environment currently requires a minimum sanitary sewer pipe size of 200 mm for all installations. This will govern all subdivision applications within Alberta.

Suggested Standard:

The following is offered for consideration:

No. of Homes Served	Min. Pipe Size (diameter)
Each house service connection	100 mm
Up to 200 (with no future upstream connection)	150 mm
Up to 400	200 mm
Up to 600	250 mm

Note: The choice of Manning "n" for different pipe materials has also been the subject of much discussion. As the friction factor changes over time because of pipe deterioration, this is considered worthy of a separate study. For this study, an average value of 0.013 has been used.

2.2 Pipe Gradients

Primary Function: To convey wastewater at a velocity adequate to prevent sedimentation.

Design Considerations:

A review of the literature on the subject indicates that a velocity of 0.75 metres/second is desirable to prevent sedimentation of typical wastewater solids. However, experience with velocities of 0.60 metres/second also indicates no appreciable sedimentation of typical wastewater solids. It can be concluded therefore that a reasonable criteria could be worded as follows:

Desirable Velocity: 0.75 metres/second
Minimum Velocity: 0.60 metres/second

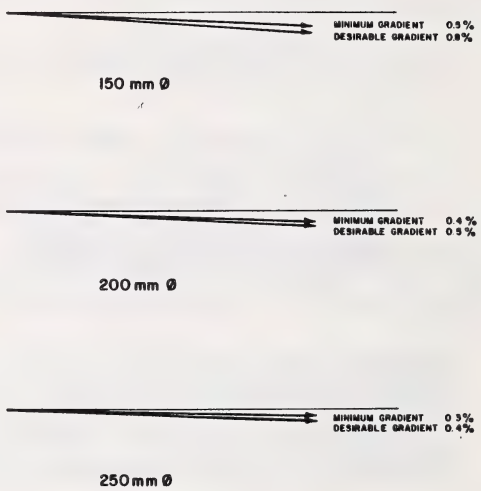
Suggested Standard:

Velocities have traditionally been calculated from the Manning equation, with a friction factor of 0.012 to 0.014 (average 0.013). Using this factor, the Manning formula yields the following gradients to achieve desirable and absolute minimum velocities:

Pipe Size (diameter)	Desirable Gradient	Minimum Gradient
100 mm*	1.5%	0.9%
150 mm	0.8%	0.5%
200 mm	0.5%	0.4%
250 mm	0.4%	0.3%

Note:

* Because of intermittent flows, it is suggested that individual 100 mm Ø house connections be laid at a minimum gradient of 2%.



MINIMUM SANITARY SEWER PIPE GRADIENTS | 2.2

2.3 Manholes

Primary Function: To allow access to the pipe systems.

Design Considerations:

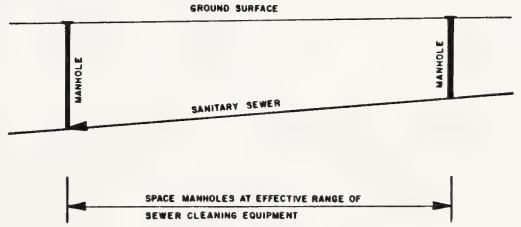
a) Manholes should be provided at all sharp bends in the piped system to enable solids to flow through and allow access for cleaning. They are also provided along straight lengths for routine cleaning and in case of blockage. The spacing of manholes along straight lengths in the piped system has been the subject of considerable discussion.

b) Modern curvilinear street designs require that sewers be laid with some curvature.

Suggested Standard:

In the final analysis, because cleaning is the manhole's primary function the only practical criterion that need be used to determine a maximum allowable spacing should be the effective range of the municipality's sewer cleaning equipment. The current range is 120 to 150 metres.

Typically, curvature in sewers is obtained by deflection at the pipe joints. Pipe manufacturers publish recommended maximum deflections for their particular type of joint. However, to ensure that some construction tolerance exists and there is some residual flexibility in the pipeline, it is suggested that the deflection on any joint should not exceed half the manufacturer's recommended maximum deflection. Curvature can also be allowed in the sewer profile along the same criteria, but it is suggested that simultaneous curvature in both horizontal and vertical planes not be allowed because of the difficulty of correct installation.



MAXIMUM ALLOWABLE MANHOLE SPACING	2.3

2.4 Sanitary Sewer House Service Connections

Primary Function: To convey wastewater from the house to the piped street system.

Design Considerations:

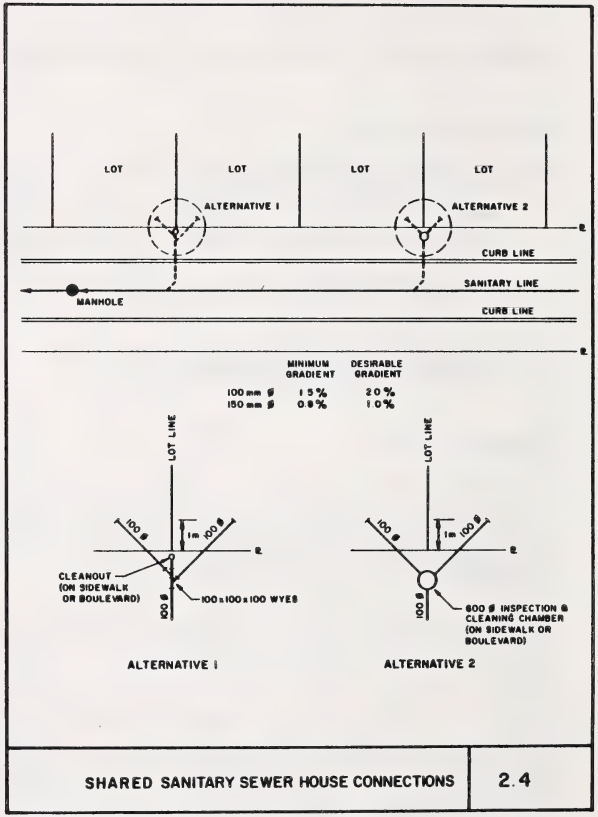
House connections have traditionally been a minimum 100 mm diameter in order to minimize the possibility of blockage. Although the required gradient to obtain a self-cleansing velocity is 1.5%, the minimum gradient usually specified is 2%. This is because of the intermittent nature of the flow from a single house.

The literature suggests there are cost benefits using shared sewer house connections by halving the number of service lines that cross the street. Some typical designs for a shared house connection are shown on Figure 2.4.

Shared sewer service connections have not been widely accepted by municipalities because of a perceived increased chance of blockage. The introduction of a cleanout or access chamber in the street right-of-way adjacent to the property line would solve this problem but also reduces the cost savings. The concrete access chamber represents an additional item for the municipality to maintain. A common cleanout allows access to clean the public part of the house connection with no increase in maintenance and is deemed acceptable.

Suggested Standard:

Shared sewer service connections can be acceptable provided their design allows access for cleaning without inconvenience to the homeowner and does not introduce additional maintenance items.



SHARED SANITARY SEWER HOUSE CONNECTIONS | 2.4

3.0 STORM DRAINAGE

3.1 Piped System

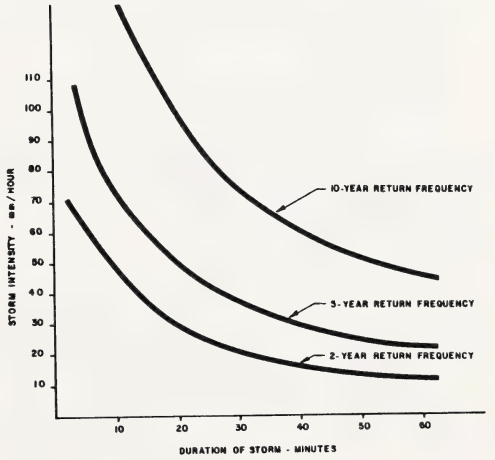
Primary Function: To carry rainwater away from private property and away from pavement on roadways.

Design Considerations:

The traditional criterion for the piped system has been that it should carry all rainwater away very quickly and with minimum inconvenience. More recently it has been acknowledged that it is cost effective to design separate systems for small storms and large storms respecting that each have a relative frequency of occurrence. Why design a pipe to carry water from a storm that is likely to occur once in 50 or 100 years? This question has evolved the "minor/major" design concept.

Simply stated, the "minor/major" concept allows the design of a piped system to carry water from a storm that may occur once in two years, or once in five years, or once in ten years, etc.; this being called the minor storm. The major storm, which might occur once in 50 or 100 years is then accommodated by some means of overland flow. This can be a combination of flow along the pavement, in ditches, and in natural drainage channels. The main constraint for the major storm is that it should not flood private property or cause public utilities to fail.

The treatment of the major storm has far-reaching consequences for both developer and municipality. Since



NOTE: THE ABOVE ARE SAMPLES ONLY

TYPICAL STORM INTENSITY - DURATION CURVES | 3.1

it is beyond the scope of this study it is sufficient to say that it should be considered within the context of an overall drainage plan of the drainage basin in which development occurs.

The main factors which affect development costs within a specific subdivision are as follows:

- the frequency of the design storm for the piped system
- pipe gradients
- manhole and catch basin spacing
- house service connections.

Out of 40 municipalities surveyed across Canada the design storms used were as follows:

2 year return frequency - 15%
5 year return frequency - 50%
10 year return frequency - 35%

Out of eight municipalities surveyed in Alberta, seven use a five year return frequency storm for design, while one uses a three year return frequency storm.

The long term effect of the minor-major concept will be to manage stormwater so as to eliminate, or at least minimize flood damage and hazard under long term storm conditions. The function of the minor (underground) system then becomes to remove surface flow to provide a reasonable level of convenience to motorists and pedestrians. If a municipality is assured, through an overall drainage plan, that all flows in excess of the minor storm will in fact drain and not create damage, the choice of the minor storm design becomes more related to convenience or nuisance.

Suggested Standard:

If it is judged by the municipality that the general attitude of the community will accept infrequent flow on streets and short-term ponding at some catch basins, then a two year return frequency storm can be considered adequate. The frequency of flow on streets and ponding can, of course, be reduced by adopting a five year return frequency storm for design. A ten year return frequency storm for the underground system, although still used by some municipalities, seems excessive.

The problem in smaller municipalities is that no rainfall intensity or frequency of occurrence graphs have been developed because of lack of records. The common practice has been to adopt the graphs of the nearest larger town with records. This practice must unfortunately continue until adequate records in all areas of the Province are gathered to formulate storm intensity and frequency curves. Higher levels of government can assist in this regard by analyzing the Province's records and delineating "atmospheric" regions. Records can then be assembled for each region and storm characteristics plotted and made available to municipalities within each region.

3.2 Pipe Gradients

Primary Function: To convey stormwater at a velocity adequate to prevent sedimentation.

Design Considerations:

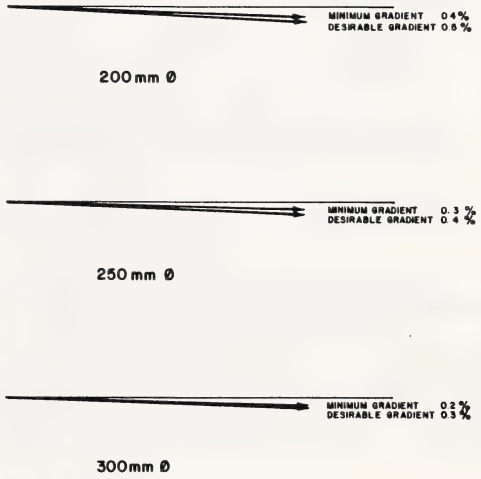
A review of the literature on the subject indicates that a velocity of 0.75 metres/second is desirable to prevent sedimentation of typical storm runoff solids. Since flushing occurs during a storm, a minimum velocity of 0.65 metres/second can prevent appreciable accumulation of sediments. It can be concluded therefore that a reasonable criteria could be worded as follows:

Desirable Velocity: 0.75 metres/second
Minimum Velocity: 0.65 metres/second

Suggested Standard:

Velocities have traditionally been calculated from the Manning equation, with a friction factor of 0.012 to 0.014 (average 0.013). Using this factor, the Manning formula yields the following gradients to achieve desirable and absolute minimum velocities:

Pipe Size (diameter)	Desirable Gradient	Minimum Velocity Gradient
200 mm	0.5%	0.4%
250 mm	0.4%	0.3%
300 mm	0.3%	0.2%



MINIMUM STORM SEWER PIPE GRADIENTS | 3.2

3.3 Manholes

Primary Function: To allow access to the pipe systems.

Design Considerations:

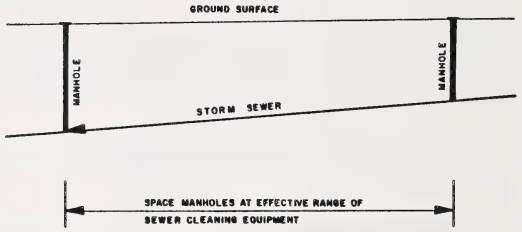
a) Manholes should be provided at all sharp bends in the piped system to enable solids to flow through and allow access for cleaning. They are also provided along straight lengths for routine cleaning and in case of blockage. The spacing of manholes along straight lengths in the piped system has been the subject of considerable discussion.

b) Modern curvilinear street designs require that sewers be laid with some curvature.

Suggested Standard:

In the final analysis, because cleaning is the manhole's primary function the only practical criterion that need be used to determine a maximum allowable spacing should be the effective range of the municipality's sewer cleaning equipment. The current range is 120 to 150 metres.

Typically, curvature in sewers is obtained by deflection at the pipe joints. Pipe manufacturers publish recommended maximum deflections for their particular type of joint. However, to ensure that some construction tolerance exists and there is some residual flexibility in the pipeline, it is suggested that the deflection on any joint should not exceed half the manufacturer's recommended maximum deflection. Curvature can also be allowed in the sewer profile along the same criteria, but it is suggested that simultaneous curvature in both horizontal and vertical planes not be allowed because of the difficulty of correct installation.



MAXIMUM ALLOWABLE MANHOLE SPACING	3.3

3.4 Catch Basins

Primary Function: To catch and direct surface rain water to the piped system.

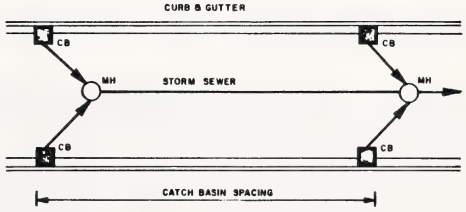
Design Considerations:

To achieve their function, catch basins must be placed at all low areas (valleys) in the pavement. They should also be placed along the length of the gutter at points where the flow exceeds the capacity of the gutter. Catch basin grating design and the use of sumps is largely a matter of preference by the municipality. Use of sumps tends to increase the maintenance requirements, but also helps to reduce peak flows and some reduction in pollutants.

The main factor which affects development costs is the spacing requirement for catch basins. Theoretically the spacing of catch basins should be determined by computing the elemental increase in flow along a gutter and locating the catch basin at the point where the flow reaches the gutter's capacity. This capacity is related to the gutter's shape and to the gradient on the street. Obviously, the steeper the street gradient, the greater the capacity of the gutter. The eight Alberta municipalities surveyed had a maximum allowable spacing ranging from 120 metres to 365 metres.

Suggested Standard:

For any gutter shape a simple formula can be worked out which relates road gradient to catch basin spacing. This would allow each length of gutter to be used to capacity while preventing spillover to the pavement. Each situation should be examined to take full advantage of the maximum capacity of the grating inlet and the carrying capacity of the gutter.



USE THE FOLLOWING CONSIDERATIONS :

1. USING MAXIMUM CAPACITY OF GRATING INLET, COMPUTE LENGTH OF STREET REQUIRED TO PRODUCE THAT STORM FLOW.
2. WIDER AND DEEPER GUTTERS WILL ALLOW MORE FLOW THAN SHALLOW, NARROW GUTTERS WITHOUT SPILLOVER TO PAVEMENT.
3. GREATER STREET LONGITUDINAL GRADIENTS WILL INCREASE GUTTER CAPACITY BUT DECREASE INLET CAPACITY OF CATCH BASIN GRATE.

CATCH BASIN SPACING	3.4

3.5 Storm Sewer House Service Connections

Primary Function: To direct roof drains and basement sub-drains to the piped system.

Design Considerations:

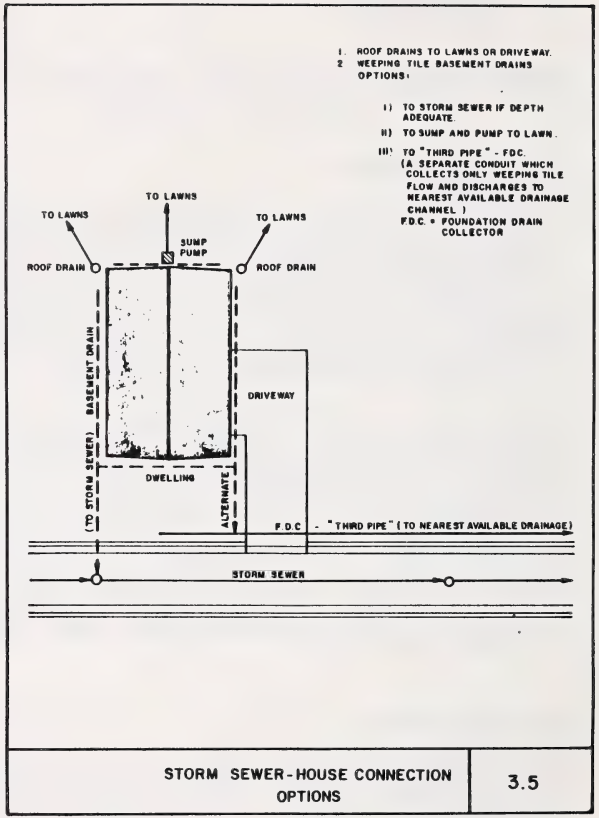
Of the forty municipalities surveyed across Canada, twenty allow discharge of roof drains to the ground. All eight municipalities surveyed in Alberta allow roof drains to discharge to the ground.

The overwhelming conclusion is that roof drains need not be connected to the street storm sewer unless the lot has no surface drainage to the street or lane (a situation which should not be allowed).

Elimination of the storm sewer house connection for roof drains leaves the problem of the basement sub-drain.

Connection of the basement sub-drain to the storm sewer has not always been satisfactory because of the danger of backflooding. Several other methods have been used:

- Connection of sub-drains to sanitary sewer
- Sub-drains directed to a sump and pumped to the surface (discharged on the ground)
- Sub-drains connected to a piped system installed exclusively for them and directed to some natural drainage course (known as a "three-pipe" system).


1. ROOF DRAINS TO LAWNS OR DRIVEWAY.
2 WEEPING TILE BASEMENT DRAINS OPTIONS:
I) TO STORM SEWER IF DEPTH ADEQUATE.
II) TO SUMP AND PUMP TO LAWN.
III) TO "THIRD PIPE" - F.D.C. (A SEPARATE CONDUIT WHICH COLLECTS ONLY WEEPING TILE FLOW AND DISCHARGES TO NEAREST AVAILABLE DRAINAGE CHANNEL.)
F.D.C. = FOUNDATION DRAIN COLLECTOR
TO LAWNS
TO LAWNS
TO LAWNS
SUMP PUMP
ROOF DRAIN
ROOF DRAIN
BASEMENT DRAIN
(TO STORM SEWER)
DRIVEWAY
DWELLING
ALTERNATE
F.D.C. - "THIRD PIPE" (TO NEAREST AVAILABLE DRAINAGE)
STORM SEWER

STORM SEWER-HOUSE CONNECTION OPTIONS | 3.5

Connection of sub-drains to the sanitary sewer can create problems when blockages occur in the sanitary sewer. Use of a sump and pump is a workable system. The main objection arises from the homeowners who do not want the added responsibility of operating and maintaining a sump pump. The use of the so-called "three-pipe" system has been found to be cost effective when compared to the traditional system connected to the storm sewer. The main reason for this is that by not connecting basement sub-drains, the street storm sewer can be installed considerably shallower and the "third-pipe" for the sub-drains can be kept relatively small.

Properly installed basement perimeter drains will provide protection against basement flooding.

Suggested Standard:

- Roof drains should discharge to the ground.
- Basement sub-drains can be directed to:
  - a sump and pumped to the surface
  - a "third pipe" draining to nearest natural drainage course.

4.0 ROADWAYS

4.1 Right-of-Way (Local Road and Minor Local Road)

Primary Function: To provide legal access to property.

Design Considerations:

The criteria considered in this section deal with the requirement for the road right-of-way width in relation to the location of public utilities. There are a multitude of variations for location of these utilities. Some of the basic criteria are concerned with public safety and operation and maintenance considerations.

Some of the basic criteria are as follows:

- Watermains should be at least 3 metres apart from sanitary sewers to minimize danger of cross-connection and contamination of water supply.
- Shallow utility corporations such as gas, telephone, etc. have a stated preference to keep such utilities outside of the paved area for maintenance considerations.
- Municipal authorities have a stated preference to keep water, sanitary and storm sewers in the most easily accessible locations for maintenance consideration.
- It is preferable to keep sanitary sewer manholes at roadway crowns to minimize inflow of storm water.

- In areas where snow cover is significant and consistent through the winter, it may be advantageous to place watermains in boulevards so that depth of cover can be reduced.

- On streets which are plowed by the municipality, adequate boulevards must be included for storage of snow.

Suggested Standard:

The general conclusions from the analysis of right-of-way requirements for public utilities can be stated as follows:

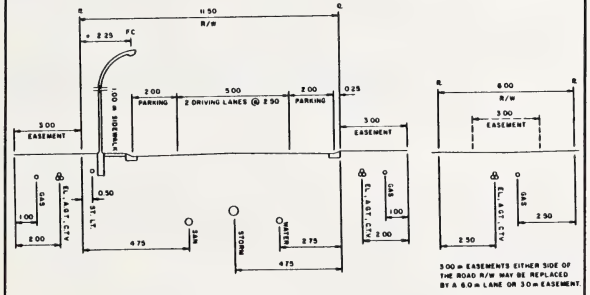
- A 6 metre pavement width will be adequate to accommodate the three deep utilities.

- A minimum width of 1.0 metre should be allocated to accommodate street lighting. This can be on one side only for local neighbourhood streets, preferably on the side with sidewalk, if provided.

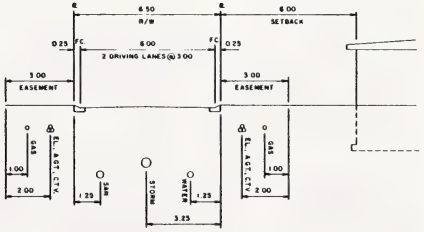
- In a laneless subdivision, shallow utilities can be accommodated by either: a 6 metre increase in the street right-of-way to accommodate shallow utilities, i.e., 3 metres on each side, or the provision of 3 metre wide easements on each side of the right-of-way. If house setbacks are appropriate, the 3 metre easement appears the more cost-efficient option.

- In a laned subdivision, it is eminently preferable to locate shallow utilities in the laneway. A 6 metre laneway can accommodate all shallow utilities and in many cases also provide room for an additional deep utility.

Figure 4.1A and 4.1B depict some typical examples of possible utility locations. These are generic examples of minimum requirements for road rights-of-way with no parking allowed and with parking allowed. Variations of road offsets can be left to the choice of the municipality.



RESIDENTIAL STREET - 11.50 m R/W (LOCAL ROAD) | 4.1A



RESIDENTIAL STREET - 6.50 m R/W (MINOR LOCAL ROAD) | 4.1B

4.2 **Paved Surface** (Local Road and Minor Local Road)

Primary Function: To provide space for convenient access to property, the movement of vehicles and pedestrians, and to provide a utility right-of-way.

Design Considerations:

a) Pavement Width:

The ability of a vehicle to move along a street is influenced by the tolerances between vehicles and between the vehicle and the curb. On residential streets where traffic volumes are low and where speed should be discouraged for safety reasons, tolerances should be considerably lower than on collector or arterial roads. On residential streets the objective is not to provide optimum vehicle flow, rather it is to combine reasonable convenience of movement and access consistent with safety and amenity. Pavement width comprises the area needed for moving lanes and an area which allows for vehicle parking (except for higher standard roadways where the primary function is vehicle movement and no parking is permitted).

i) Moving Lanes

An analysis of the literature suggests the following requirements for moving lanes in a residential environment.

Pavement Width	Service
5.5 m	• Allows two large service vehicles to pass with a 0.5 m tolerance. • Provides good clearance for all smaller vehicles. • This width is the maximum which needs to be used for moving lanes on local residential streets.
5.0 m	• Allows for a large car and large service vehicle to pass with free flow and 0.5 m tolerance.
4.5 m	• Allows two large cars to pass with free flow and tolerance of at least 0.5 m.
3.0-4.5m	• Suitable only for one way systems and private driveways.

ii) Parking Lanes

The decision on whether or not to include additional lanes for on-street parking is dependent on a number of factors, including:

- provision for off-street parking
- density of development
- average family size and age
- income levels
- availability of public transportation.

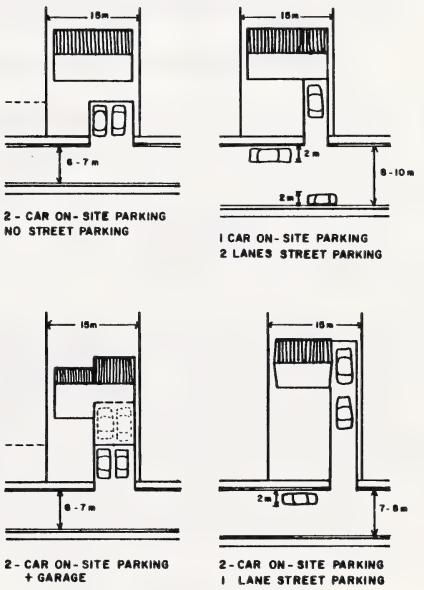
It is not possible, therefore, to provide a rule-of-thumb for the provision of parking. However, in Alberta on-street parking has become an expected facility in most single detached housing subdivisions. This is not the case in other countries or in many condominium or attached housing developments where the streets are used primarily for vehicular movement with parking being accommodated on the lot and/or in parking bays.

Many attractive residential neighbourhoods have been spoiled by excessive on-street parking. In many instances this includes two rows of parked cars and an assortment of recreational vehicles such as converted school buses and commercial vehicles owned and operated by residents. Parked vehicles can also be hazardous, particularly in areas with young children.

In spite of the arguments against on-street parking it is clear that with the trend towards smaller lots there is a need for a combination of on-street and off-street parking. A minimum of two off-street spaces should be provided. On streets with housing frontage both sides, two parking lanes with minimum widths of 2 m (desirable 2.25 m) should be provided if no other parking bay provision is made. Streets with frontage one side only do not require two parking lanes. Parking lanes should not be provided on collectors without frontage and arterial streets.

In a normal subdivision with 15 m and larger lot frontages, two or more cars can be accommodated off-street (Figure 4.2A) and one or more on-street.

With narrow lots of 10 and 12 metres conflicts occur when on-street parking begins to limit the accessibility to the off-street pad or side driveway. Where this conflict



LOCAL ROAD PAVEMENT WIDTHS | 4.2 A

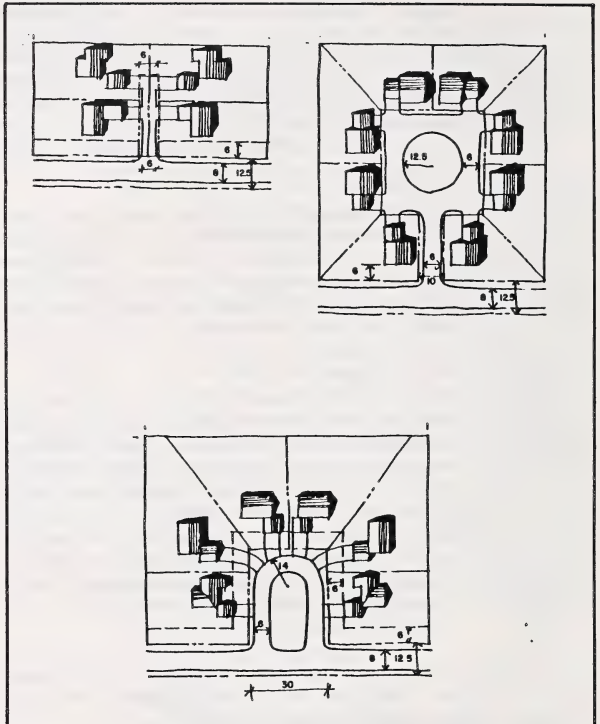
becomes severe it will be necessary to either eliminate the street parking or the vehicular access to the lot from the front. If street parking is eliminated parking bays should be provided at strategic points throughout the development (as in multi-family). If front vehicle access to the lot is not permitted then access to the rear via a lane must be provided.

Suggested Standard:

Residential streets which require two moving lanes and two parking lanes normally require a minimum of 9 m between inside of curbs. This will allow 2 x 2 m parking lanes and 2 x 2.5 m driving lanes. Cul-de-sac radius to inside of curb should not normally exceed 11 m unless located in a higher density area.

Cul-de-sacs, crescents etc. have been developed successfully with 7 m wide pavements providing one parking lane and two driving lanes, or one wide driving lane and two parking lanes. Studies conducted by the Urban Land Institute concluded that "The level of resident inconvenience occasioned by the lack of two moving lanes is remarkably low. In fact, no appreciable difference in driver convenience is generally noted between a 26 foot (7.92 m) wide and a 36 foot (10.97 m) wide pavement unless the neighbourhood layout permits travel distances in excess of three blocks between dwelling and collector street."

Short cul-de-sacs and one way loop roads serving up to 8 units can be developed with 6 m pavements, as shown on Figure 4.2B. This standard will allow a service truck to easily pass a parked car. Pavement widths below 6 m are not recommended for public roads serving residential housing.



MINOR LOCAL ROAD PAVEMENT WIDTHS | 4.2B

4.3 Lanes

Primary Function: To allow access to residential property.

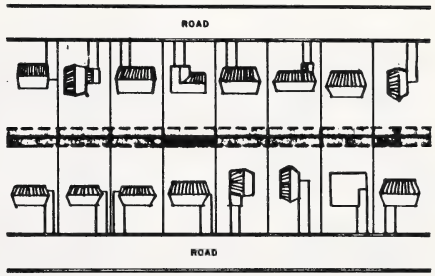
Design Considerations:

The major question with regard to lanes is not so much the size but whether or not they are really required. Most modern neighbourhood and subdivision designs do not use lanes. The increasing use of underground power lines, trends in the use of front drive/garage house designs and the cluster housing concept, and the movement away from gridiron-streets and block patterns has eliminated the need for lanes. Alleys may offer advantages for multi-family projects which are designed with rear vehicle parking and commercial garbage containers. Many municipalities defend the use of lanes because it allows rear utility servicing and lower costs for repair should a break occur. However, this possible saving in maintenance is usually not balanced against the additional cost to the municipality in lane maintenance, lighting, police patrol and density loss.

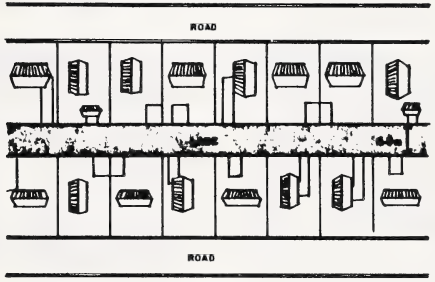
Suggested Standard:

If lanes must be incorporated in a subdivision consideration should be given to reducing the street right-of-way to 12 m and limiting the lane to 6 m. This will require the same land area as an 18 m street with no lane.

Lanes do provide an efficient location for shallow utilities which avoids the need for shallow utility easements or assignments on both sides of the street pavement. In some cases, sewer and water lines are placed in lanes because they do not require extensive backfill compaction and trench settlements are relatively easy to repair.



LANELESS - FRONT DRIVEWAYS
3 - METRE SHALLOW UTILITY OR DRAINAGE EASEMENT AT REAR OF LOT



LANED - REAR DRIVEWAYS
6 - METRE LANE FOR SHALLOW UTILITIES
UP TO 8 METRES IF MORE UTILITIES ARE DESIRED

LANES	4.3

4.4 Sidewalks

Primary Function: To provide space for the movement of pedestrians which is segregated from the space required for the movement of vehicles.

Design Considerations:

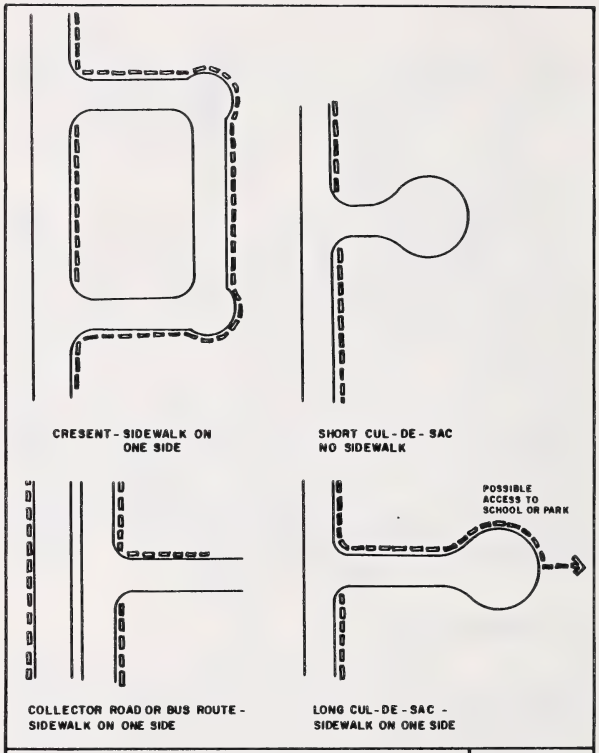
The need for a sidewalk is dependent on the expected use. In many locations, such as short cul-de-sacs and crescents and low density development areas the sidewalk can be eliminated entirely or reduced to one side only. However, where the route involves higher density development, access to schools, shops, parks etc. sidewalks should be provided (Figure 4.4).

Minor sidewalks are often of monolithic design and 1 m wide. Principal pedestrian routes should have sidewalks of approximately 1.5 m.

Suggested Standard:

Requirement for sidewalks on minor streets can be eliminated unless they form part of a specific walkway route to an activity area.

Local roads should have sidewalks but in most cases these can be on one side only.


CRESENT - SIDEWALK ON ONE SIDE
SHORT CUL - DE - SAC NO SIDEWALK
POSSIBLE ACCESS TO SCHOOL OR PARK
COLLECTOR ROAD OR BUS ROUTE - SIDEWALK ON ONE SIDE
LONG CUL - DE - SAC - SIDEWALK ON ONE SIDE
SIDEWALKS
4.4

5.0 PLANNING

5.1 Housing Mix

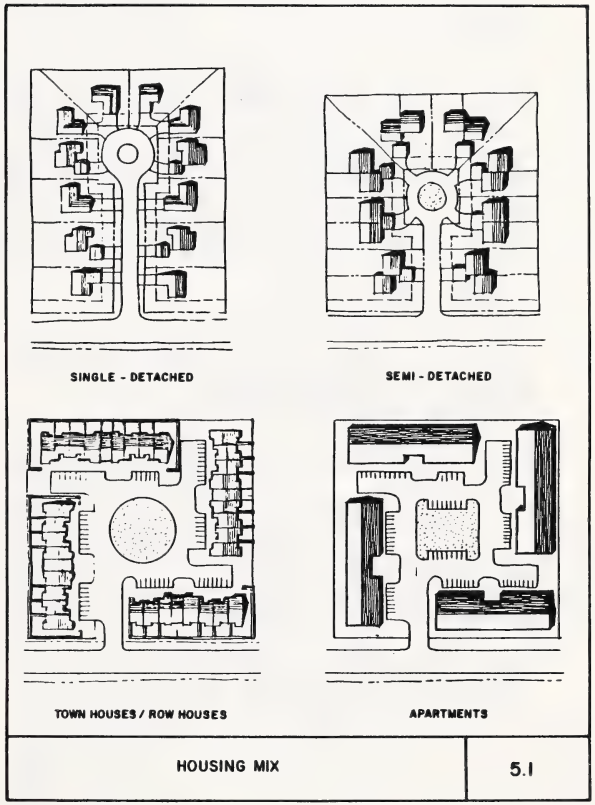
Primary Function: To encourage a variety of housing types and price ranges suitable for various family sizes, income levels and life styles.

Design Considerations and Suggested Standards:

Municipalities should consider three main criteria when reviewing housing mix in development proposals.

1. Size of development site
2. Location of development site
3. Existing demand/market for different type of housing

a) Size of Site: The larger the development project the more feasible it is to incorporate a good housing mix. On the neighbourhood scale it is desirable to achieve a diversity of housing types. This will help to create a well balanced community structure where a family can adjust its housing needs in terms of size, life style and income level without being forced to relocate to a new neighbourhood or community. This is a major advantage to the municipality as it keeps local school, recreation and community facilities viable over the long term. For small sites of less than 10 hectares (25 acres) it is normally advisable not to mix houses with a wide price range. The old rule of thumb is that "Houses



facing each other should be of similar price and quality". This does not mean that all houses should look alike.

b) Location: The historic approach of concentrating all multi-family housing towards the centre of the neighbourhood adjacent to schools and shops is not visually desirable as it tends to create a wall of high density which may detract from the amenity of the neighbourhood and create excessive traffic movement through the neighbourhood. Some general locational criteria are set out below.

Large Lot Single Detached
Emphasis on peripheral locations.

Medium Size Single Detached/Small Lot Single Detached/Semi-detached/Duplex
Distributed throughout neighbourhood.

3 and 4 Attached Units/Townhouses/Low rise (walk-up) Apartments
Emphasis on locations near transit routes, collector roads, commercial sites and elementary schools.*

High Density Apartments
Should be located near transit routes, core areas, retail and employment centres etc.

Senior Citizens/Retirement Housing
Emphasis on location close to transit route and commercial facilities.

*Small 1 and 2 bedroom apartments are normally adult orientated and they do not benefit from locations close to schools.

From a neighbourhood efficiency point of view it is important to locate higher density development close to the major collector and potential bus routes. This not only makes the major road system and transit service (if available) more viable but also helps to avoid vehicle short-cutting through local residential streets.

c) Market: The market demand at any given time has a marked effect on the viability of different housing styles. It would therefore be unreasonable for a municipality to strictly enforce housing types or mix. However, it is feasible for the municipality to establish through its General Municipal Plan and Area Structure/Redevelopment Plans guidelines for housing mix and density targets. If, subsequently, a development proposal is received which does not attempt to meet the guidelines, the developer should be asked to give good reasons for non-conformance. Some examples of housing mix guidelines and the approximate resulting overall gross densities are shown on the following page.

TABLE 2.1: PERCENTAGE OF TOTAL UNITS

Detached	Semi-Detached Duplex	Town Houses	Low Rise	APPROXIMATE DENSITY* Units/ha net	Units/ha gross	Units/Acre net	Units/Acre gross
80%	5%	10%	5%	20.5	12.3	8.3	5.0
60%	15%	15%	10%	27.0	16.2	10.9	6.6
50%	10%	20%	20%	30.4	18.2	12.3	7.4

* Assuming 60% Res Lots, 25% Roads, 10% Park, 5% Other

5.2 Zero Lot Line Concept

Primary Function: To provide better utilization of the lot and increased density with minimal loss of amenity.

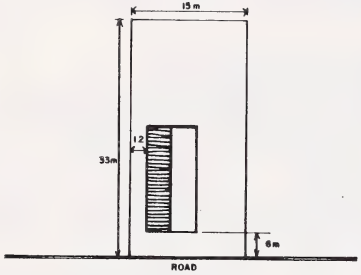
Design Considerations:

The zero lot line has advantages from a space efficiency point of view. Illustration A on Figure 5.2 shows a standard 33 m x 15 m lot with a house located 1.2 m from the left hand lot line. Illustration B shows the same house with a zero side yard design. In this case the lot width can be reduced to 13.8 m by eliminating the side yard. To keep the lot area the same (495 m^2) the extra depth is added to the rear yard. The other side yard and street set back remain unchanged. Overall, the zero side yard house gains 22 m^2 of usable rear yard space with small reduction in front yard area of 7.2 m^2.

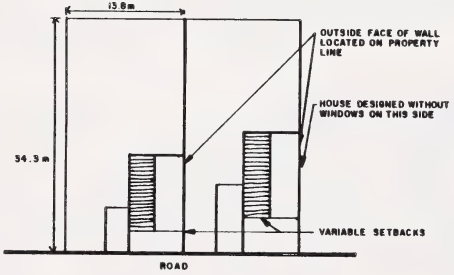
Suggested Standard:

In the above example an 8% saving of road frontage is achieved which translates into a 1.4% improvement in net density. If the rear usable yard area is maintained at 225 m^2, the lot dimensions are 13.8 x 34.3 m, which represents a 4.3% increase in net density. The zero side yard concept can also allow narrower lots to be developed while still maintaining space for a driveway on one side.

This type of development requires pre-selection of house types to eliminate view windows on one side and special legal provisions to allow the homeowner access to the adjacent lot for maintenance purposes. Drainage from eavestroughs should not be discharged to the neighbour's yard. The benefits of a rear yard are greatest on lot widths below 15 m but the zero lot line concept will provide more efficient use of space on any size lot.



CONVENTIONAL 'A'



ZERO LOT-LINE 'B'

ZERO LOT-LINE	5.2

5.3 Housing Density

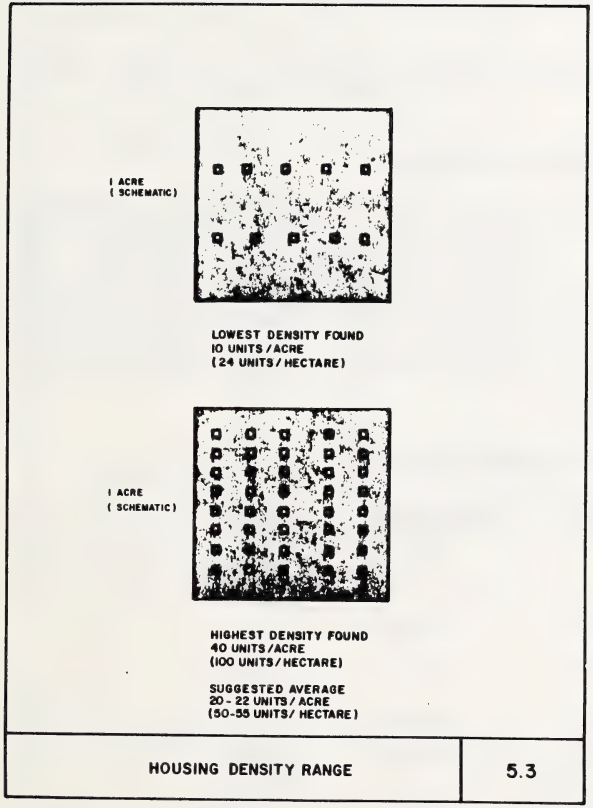
Primary Function: To provide a measure of the distribution of housing units in relation to a given land area.

Design Considerations:

The housing density figure is a useful tool for assessing the yield and efficiency of development proposals. However, an important distinction exists between gross and net density.

a) Gross Density: This is the most common density measure for subdivision and neighbourhood planning. To calculate gross density the total number of housing units proposed is divided into the developable land area for the total project. This developable area would include lots, park, school site, roads, lanes, local commercial area etc. For example if 300 houses are proposed on 20 hectares (50 acres) of developable land the gross density would be 15 houses/hectare (6 houses/acre). In most large subdivisions only about 60% of the developable land can be used for residential lots with the other land uses making up the balance.

Typical Subdivision Land Use Breakdown	
Housing Lots	60%
Roads	25%
Park/Schools	10%
Commercial/Other	5%
	100%



Typical Gross Densities

Mixed	12-20/hectare; 5-8/acre
Single Detached	14-15/hectare; 5-6/acre

b) Net Density: When calculating net density the total number of housing units is divided by the area used for residential lots only. Net density is directly related to the size of lots. For example, if the area remaining for residential lots amounts to 12 hectares (30 acres), after the areas for roads, parks, schools and local shops have been subtracted, and the development contains 300 houses the net density would be 25 houses/hectare (10 houses/acre). With 25 houses on each hectare of land the average size of each lot would be 400 m^2. Typical Net Density ranges are listed below.

House Type	Net Density/Hectare (Acre)	
Single-Detached	7.5-30	(3-12)
Semi-Detached or Duplex	22-36	(9-15)
Town House/Row Houses	24-45	(10-18)
Walk up Apartment 2-3 stories	30-60	(12-25)
Multi Storey Apartment up to 8 stories	60 and up	(25 and up)

Suggested Standard:

It is in the interests of the municipality to encourage construction of higher density housing as this will result in more efficient use of both the road and utility systems and a reduction in per capita maintenance and operation expenditures. Limitations on density will be shaped by the market place. The objective is to obtain the highest average density consistent with good amenity and buyer acceptance. In many municipalities the 465 m^2 lot has become the accepted average for a single-detached home. However, higher overall densities are desirable for cost efficiency both from the developer's and municipality's point of view.

5.4 Lot Area and Frontage

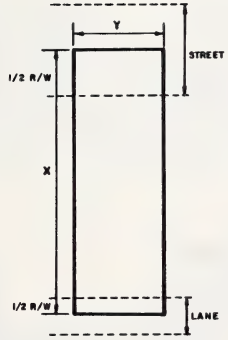
Primary Function: To improve housing density without reducing lot area.

Design Considerations:

a) Lot Unit: For the purposes of assessment, Figure 5.4A shows a typical access requirement for a residential lot in a laned subdivision. The requirement includes half the road in front of the lot and half the lane to the rear. This total area is called the lot unit. The Table below shows how the percentage road/lane area changes with different road/lane standards. In each case the lot is 15 m x 33 m.

TABLE 2.2 ROAD AREA AND FRONTAGE

Access Type Road/Lane	Area of Lot Unit	Area of Road/Lane	**Road & Lane As % of Lot Unit**	Density Achieved Lot Units/ha
18m/9m	697.5 m^2	202.5 m^2	**29.0 %**	14.3
15m/6m	652.5 m^2	157.5 m^2	**24.1 %**	15.3
12m/6m 18/No Lane	630.0 m^2	135.0 m^2	**21.4 %**	15.9
15m/No Lane	607.5 m^2	112.5 m^2	**18.5 %**	16.5
12m/No Lane	585.0 m^2	90.0 m^2	**15.4 %**	17.1
8.5m/No Lane	558.7 m^2	63.8 m^2	**11.4 %**	17.9

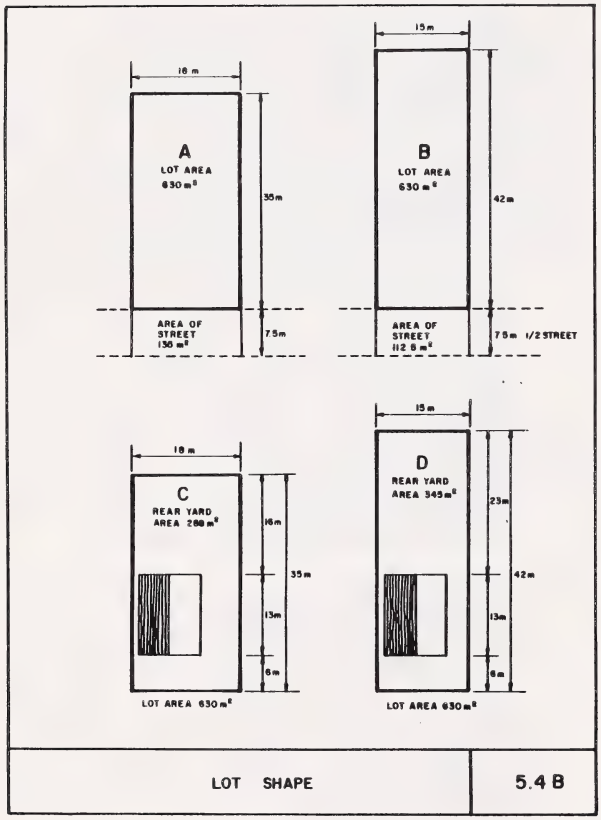


LOT AREA | 5.4A

The primary aim is to reduce the amount of street right-of-way required to support each dwelling. Lanes are a major user of land and in some subdivisions account for as much as 10% of the developable area. In the example of the 18 m road and 9 m lane, the right-of-ways are 29% of the developable area. In contrast the 15 m right-of-way with no lane reduced this percentage to 18.5 -a 36% improvement. This modified standard would also improve the yield by two lots per hectare which is equivalent to a 14% increase in density.

In special areas such as planned unit developments and manufactured housing communities 8.5 m rights-of-way have been used successfully for crescents and cul-de-sacs. The pavement width is reduced to between 6 and 7 metres and on-street parking is limited to one side only. Front or rear yard easements are required for some utilities. There are many good examples of comprehensively planned detached housing areas where streets and street rights-of-way take up less than 15% of the developable land area. Twenty percent would be a good target figure for a new subdivision.

b) Lot Shape: Lot shape also has an effect on the lot to road ratio and ultimate density achieved. From an efficiency point of view it is better to increase lot depth rather than width to obtain the same lot area. The example on Figure 5.4B, shows two 630 m^2 lots. Lot A has 18 m x 35 m dimensions while Lot B has 15 m x 42 m dimensions. Because of the narrower frontage, Lot B requires 16.7% less road right-of-way. Overall net density in the subdivision would be increased by 3%. Lot area would remain unchanged.



LOT SHAPE | 5.4 B

With a 130 m^2 bungalow placed in a similar location on each lot (see Lots C and D) the narrower lot provides 20% more rear yard space and increases the separation between backs of houses by 14 m or 53%. This increased separation not only improves privacy but also provides better solar access in the winter months when sun angles are low.

Suggested Standard:

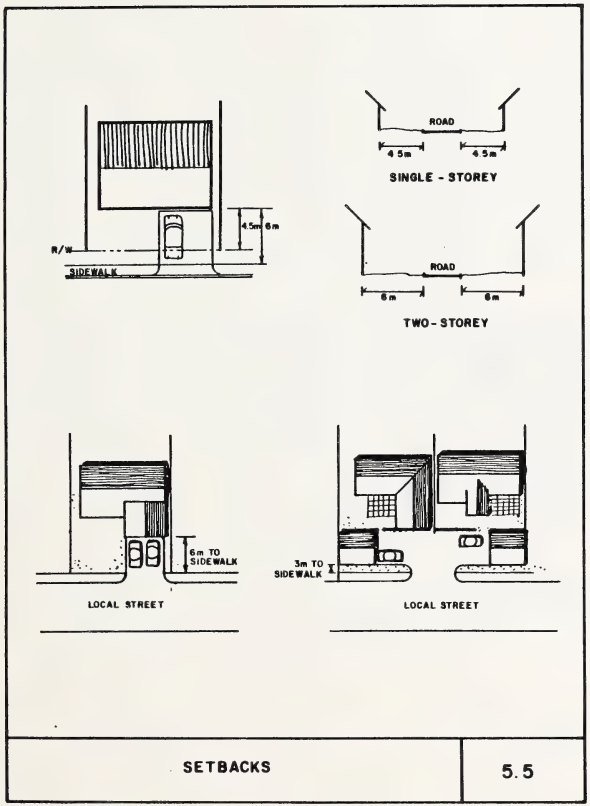
No overall standard is suggested but it is evident that provision of flexibility in lot design can improve subdivision efficiency as well as amenity. Minimum lot areas should be kept to approximately 200 square metres and frontages to a minimum of 7.5 metres.

5.5 Setbacks

Primary Function: To provide a separation space between the public road right-of-way and the dwelling.

Design Considerations:

On a normal residential street with front access to a garage on parking pad the minimum setback from the road right-of-way should be 6 m (Figure 5.5). This will allow a car to park in front of the garage without infringing on the sidewalk or pavement.



SETBACKS	5.5

Front yard setbacks could be reduced to 4.5 m where:

- all houses have side driveways
- lot access parking is from a rear lane
- special parallel garage design is incorporated
- the distance between the pavement and the edge of the right-of-way can be used to accommodate part of the parking.

Note:

Areas with numerous two storey houses, narrow roads and setbacks may produce an undesirable canyon effect. Conversely, in single storey developments, including manufactured housing communities, narrower setbacks are quite acceptable and can enhance the "human scale" feeling of the development.

Suggested Standard:

- 6 metre minimum setback if front drive garage or parking pads are permitted.
- 6 metre minimum setback from R/W for two-storey homes.
- 4.5 metre minimum setback from R/W for single-storey homes.
- 3 metre minimum setback for special design.

·CHAPTER· THREE·

TEST CASE AND COMPARATIVE COSTS

INTRODUCTION

The subject of this chapter is a capital construction cost comparison between a subdivision designed with current practice and one designed with the suggested practices put forward in Chapter Two. For the purpose of this report, it has been decided to adopt the terms "Traditional" and "Modified" for the two subdivision designs. The purpose of this exercise is to identify capital cost differences in a test-case subdivison. The comparison is carried out on an element-by-element basis so as to enable assessment of the relative merits of modification of any given element.

The report is developed by providing a description of the parcel of land selected, the basic assumptions used in the design and a listing of the design criteria for the two subdivisions to be compared. It then provides a breakdown of the unit costs used in the cost comparison and proceeds to develop the overall costs of the two subdivisions.

The first part of the Chapter compares capital construction costs of the two subdivision designs.

The second part of this chapter deals with annual maintenance and operation costs. Unit costs are developed from the records of several municipalities and these are applied to the elements in each of the two subdivisions and compared.

1.0 THE SUBDIVISION

The parcel of land selected for the comparison is located in the City of Red Deer, is approximately 12 hectares and lies adjacent to an existing subdivision bounded by 39th Street and 30th Avenue. The land is gently rolling, sloping to the northwest, with a shallow coulee running diagonally through the site. The parcel is typical of many found in southern and central Alberta.

A collector road joining 39th Street to 30th Avenue, is part of the original design and this has been used as the northwest boundary of the parcel. The design of the collector road is the same in both schemes. The traditional subdivison design is shown on drawing 1 on page 62 and the modified subdivision layout is shown on drawing 2 on page 63.

It has been assumed that soil conditions are favourable and that no extra costs or special measures are required to overcome soils problems. The land is not treed and no clearing costs have been included.

In both cases it has been assumed that frontage lots will be allowed on the collector road, but not on 39th Street or 30th Avenue as these are major thoroughfares. A buffer strip of 6 metres has been allowed on 39th Street and 20 metres on 30th Avenue. Table 3.1 presents a list of the major differences in design elements in the two subdivisions and compares the land use statistics and development densities achieved with the two schemes.

No attempt has been made to use "zero lot line" or townhousing to increase density in order to keep the comparison on a closely equivalent basis. In both cases, the overall appearance of the subdivision is that of a traditional single-family dwelling neighbourhood.

The traditional design is typical of the approach used in Alberta for some years and can be described as a variation on the standard grid subdivision. Parts of the road grid are re-oriented to form a series of crescents or p-loops. The traditional layout also includes rear laneways, again a practice very typical in the Province. The public reserve park area shown is located on an island which provides an attractive but expensive, due to the lost road frontage, amenity feature. Residential lot dimensions are generally 18 metres wide x 35 metres deep.

The modified design by comparison maintains a single, clearly identifiable residential collector road as opposed to the two less well defined roads in the traditional layout. The crescents are replaced by two cul-de-sacs and the laneways are eliminated. In addition to making the subdivison more attractive and marketable, the combination of road layout changes, elimination of lanes and somewhat smaller rights-of-way reduces both the area of roads and lanes from over 28 percent of the total site to less than 13 percent, a saving of 1.91 hectares of land. Road length is also reduced from 1,185 metres to 1,025 metres, a 13.5 percent saving. Over 1,500 metres of laneway are also eliminated. These changes should contribute to improved road safety and reduced maintenance costs.

The island park has been replaced by a park which retains some frontage on the residential collector but also extends into the centre of the subdivision backing onto 14 lots. It is now more functional in terms of being accessible to a greater number of residents, almost 60 percent larger, serves as a walkway through the subdivision, and is more attractive to the home purchaser. Lots backing onto parks have proven very popular in comparison to feature green areas typified by the earlier island park.

Lot dimensions have also been modified. The width has been reduced to an average of 15 metres while the average depth increased to between 40 and 45 metres. The improvements in this approach are substantial. Although less wide (approximately 17 percent) the 14 to 29 percent increase in depth offers several advantages.

The non-functional side yard typically attached to most homes is now replaced with added depth on the rear yards, an area which is far more important to the homeowner in terms of functionality. The added lot depth also more than compensates for the removal of laneways. Homes on backing lots are in fact likely to be further away than if laneways were present. Variable setbacks for the homes can also be used to further enhance the overall appearance.

The slightly narrower lot widths also compensate for the loss in road frontage due to reduced road lengths. In this comparison, the combination of design changes has increased both the area actually used for lots from 7.42 ha (61.8%) to 9.18 ha (76.5%), a 24 percent change. The number of lots has also grown to 140 from 120, a 17 percent increase. Overall development density is also improved by about 17 percent.

Table 3.1 on page 54 lists the main differences in design between the Traditional and Modified layouts in terms of the elements discussed in Chapter Two. The Traditional column reflects average current practice in Alberta in terms of roadway, lot sizing and servicing standards. The Modified column reflects the ideas presented in Chapter Two.

TABLE 3.1

DESIGN CRITERIA

	ELEMENT	TRADITIONAL	MODIFIED
1.	Average lot dimensions	18 m x 35 m	15 m x 42 m
2.	Average lot area	630 m^2	630 m^2
3.	Collector Road R.O.W.	22 m	22 m
4.	Local Road R.O.W.	18 m	15 m
5.	Minor Local Road R.O.W.	18 m	12 m
6.	Collector Road Pavement Width	12.5 m	12.5 m
7.	Local Road Pavement Width	10.0 m	8.0 m
8.	Minor Local Road Pavement Width	10.0 m	6.0 m
9.	Laneways	8.0 m	N/A
10.	Sidewalks (Collector Road)	Monolithic - both sides	Monolithic - both sides
11.	Sidewalks (Local Road)	Separate - both sides	Monolithic - one side
12.	Sidewalks (Minor Local Road)	Separate - one side	No sidewalk
13.	Watermains - min. size (local road)	150 mm	150 mm

TABLE 3.1 - Continued

	ELEMENT	TRADITIONAL	MODIFIED
14.	Watermains - Min. size (minor local)	150 mm	50 - 100 mm
15.	Hydrant Spacing	150 m	300 m
16.	Line Valve Spacing	150 m	every 40 dwellings
17.	Valves at Intersections	2	2
18.	Water house service connections	19 mm for each lot	25 mm for every two lots
19.	Sanitary Sewer - Min. Pipe Size	200 mm	150 mm
20.	Manhole spacing (sanitary)	150 m	160 m
21.	Curved Sewers (sanitary)	not allowed	allowed
22.	Sewer house connections	100 mm for each lot	100 mm for every two lots
23.	Design storm frequency	5-year	2-year
24.	Storm Sewer - Min. Pipe Size	300 mm	250 mm
25.	Manhole spacing (storm)	150 m	160 m
26.	Curved sewers (storm)	not allowed	allowed
27.	Catch basin spacing	150 m	160 m
28.	Storm sewer house connections	not provided	not provided
29.	Gross site area	12.00 ha (100%)	12.00 ha (100%)

TABLE 3.1 - Continued

	ELEMENT	TRADITIONAL	MODIFIED
30.	Roads: Streets	2.16 ha (18.0%)	1.50 ha (12.5%)
	Lanes	1.25 ha (10.4%)	-
	Total	3.41 ha (28.4%)	1.50 ha (12.5%)
31.	Buffers	0.91 ha (7.6%)	0.91 ha (7.6%)
32.	Park	0.26 ha (2.2%)	0.41 ha (3.4%)
33.	Housing	7.42 ha (61.8%)	9.18 ha (76.5%)
34.	No. of Lots	120	140
35.	Gross density *	10.0 units/ha	11.7 units/ha
36.	Net density *	16.2 units/ha	15.3 units/ha

* Note that gross and net density are defined in Section 5.3 of Chapter Two, page 45 - 46.

2.0 UNIT COSTS

The unit costs for each element of the subdivison were derived from 1986 tendered prices (averaged), combined with material supply costs from Calgary suppliers of pipe, castings, fittings, pre-cast concrete, asphaltic concrete, etc. The following is a list of the unit costs used for this report. These unit costs were applied equally to both subdivision designs to arrive at the overall cost comparision. Costs are total for supply and installation.

TABLE 3.2
UNIT COSTS

Siteworks	
Topsoil Stripping and Stockpiling	$1.70/m^3
Sub-Grade Preparation	$1.40/m^2
Common Excavation	$4.25/m^3
Excavation to Stockpile	$5.50/m^3
Screeen & Re-Spread Topsoil	$3.50/m^3
Preparation & Seeding	$0.50/m^2
Roadworks	
75 mm pit run gravel	$7.00/tonne
19 mm crushed gravel	$8.50/tonne
Prime coat	$0.40/m^2
Tack Coat	$0.30/m^2
Asphaltic Concrete (regular mix)	$45.00/tonne
Asphaltic Concrete (top lift fine mix)	$52.00/tonne
Concrete Works	
1.4 m wide monolithic curb and gutter	$50.00/m
1.4 m wide sidewalk	$38.00/m
250 mm curb and gutter	$26.00/m
Aprons (for driveways or lanes)	$50.00/m^2
Waterworks	
50 mm diameter: 3 m depth	$90.00/m
150 mm diameter: 3 m depth	$98.00/m
200 mm diameter: 3 m depth	$108.00/m
250 mm diameter: 3 m depth	$120.00/m
Fire hydrant - complete assembly with 100 mm Tee, Valve, Lead, etc.	$3,400.00 each
Gate Valves: 50 mm	$230.00 each
150 mm	$400.00 each
200 mm	$520.00 each
250 mm	$650.00 each
Fittings (Tees, Elbows):	
50 mm	$200.00 each
150 mm	$480.00 each
200 mm	$560.00 each
250 mm	$680.00 each
Tapping saddles and corporation stops	$120.00 each
Curb Stops	$170.00 each
19 mm diameter copper service line	$78.00/m
25 mm diameter copper service line	$80.00/m

TABLE 3.2 - Continued

Sanitary Sewers

150 mm diameter:	2 - 3 m depth	$90.00/m
	3 - 4 m depth	$96.00/m
200 mm diameter:	2 - 3 m depth	$95.00/m
	3 - 4 m depth	$101.00/m
250 mm diamter:	2 - 3 m depth	$102.00/m
	3 - 4 m depth	$108.00/m
300 mm diameter:	2 - 3 m depth	$110.00/m
	3 - 4 m depth	$118.00/m
Manholes:	2 - 3 m depth	$1,500.00 each
	3 - 4 m depth	$1,900.00 each
	4 - 5 m depth	$2,300.00 each
100 mm diameter house service line		$86.00/m
100 mm x 100 mm x 100 mm WYE fitting		$35.00 each
100 mm diameter cleanout and cap		$80.00 each

Storm Sewers

250 mm diameter:	2 - 3 m depth	$110.00/m
	3 - 4 m depth	$115.00/m
300 mm diameter:	2 - 3 m depth	$116.00/m
	3 - 4 m depth	$122.00/m
450 mm diameter:	2 - 3 m depth	$140.00/m
	3 - 4 m depth	$145.00/m
600 mm diameter:	3 - 4 m depth	$182.00/m
250 mm diameter catch basin leads		$88.00/m
Catch Basins complete with grate		$1,200.00 each
Manholes:	2 - 3 m depth	$1,500.00 each
	3 - 4 m depth	$1,900.00 each
	4 - 5 m depth	$2,300.00 each

3.0 ESTIMATED CONSTRUCTION COSTS

The following section details the measured quantities and estimated costs for both subdivision designs. Since the design of the collector road is the same in both instances, a total cost has been worked out and half of that total is allocated to the cost of the subdivision. The collector road breakdown is shown on Table 3.3.

The remainder of the cost breakdown (Table 3.4), page 60, is set up with parallel columns for the "Traditional" design and "Modified" design. Thus quantities and total costs can be compared on an item-by-item basis. This will enable a detailed analysis of which elements represent the maximum savings.

It should be noted that the following are construction costs only and do not include financing, legal, administration, engineering, or profit. No shallow utility costs are involved in this analysis since these are generally installed by the local agencies that administer them. Street lighting is also omitted from this comparison since the costs would be equivalent for the two subdivisions.

TABLE 3.3

COLLECTOR ROADWAY COST

	ITEM DESCRIPTION	UNIT	UNIT PRICE	QUANTITY	COST
1.	Topsoil Stripping	m^2	1.70	2,200	$ 3,740
2.	Sub-grade Preparation	m^2	1.40	8,400	11,760
3.	Common Excavation	m^3	4.25	800	3,400
4.	Excavation to Stockpile	m^2	5.50	320	1,760
5.	Screen and re-spread topsoil	m^3	3.50	600	2,100
6.	Preparation and Seeding	m^2	0.50	4,900	2,000
7.	75 mm pit run gravel	tonne	7.00	3,530	24,710
8.	19 mm crushed gravel	tonne	8.50	1,770	15,045
9.	Prime Coat	m^2	0.40	8,400	3,360
10.	Tack Coat	m^2	0.30	16,300	5,040
11.	Asphaltic concrete (regular)	tonne	45.00	1,520	68,400
12.	Asphaltic concrete (top lift)	tonne	52.00	510	26,520
13.	1.4 m monolithic sidewalk and curb	m	50.00	1,360	68,000
14.	250 mm watermain	m	120.00	645	77,400
15.	Hydrants	each	3,400.00	4	13,600
16.	250 mm gate valves	each	650.00	6	3,900
17.	250 mm fittings	each	680.00	5	3,400
18.	250 mm san. sewer:				
	2 - 3 m depth	m	102.00	240	24,480
	3 - 4 m depth	m	118.00	250	29,500
19.	300 mm san. sewer:				
	2 - 3 m depth	m	110.00	90	9,900
	3 - 4 m depth	m	118.00	70	8,260
20.	Manholes: 2 - 3 m depth	each	1,500.00	4	6,000
	3 - 4 m depth	each	1,900.00	2	3,800
21.	300 mm storm sewer:				
	2 - 3 m depth	m	116.00	150	17,400
22.	450 mm storm sewer:				
	2 - 3 m depth	m	140.00	290	40,600
23.	600 mm storm sewer:				
	3 - 4 m depth	m	182.00	70	12,740
24.	Manholes: 2 - 3 m depth	each	1,500.00	4	6,000
	3 - 4 m depth	each	1,900.00	2	3,800
TOTAL					$496,615

TABLE 3.4

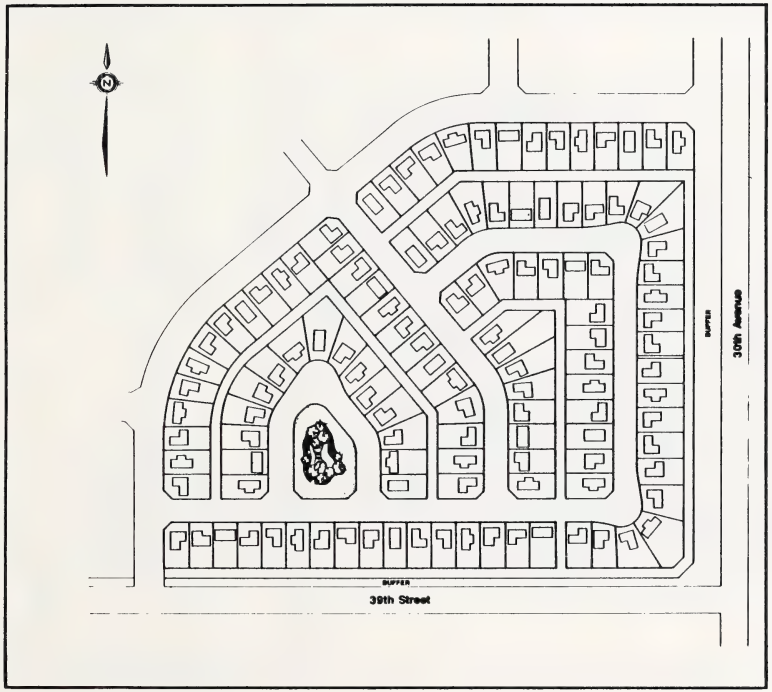
RESIDENTIAL SUBDIVISION COSTS

	ITEM DESCRIPTION		UNIT	UNIT PRICE	TRADITIONAL		MODIFIED	
					QUANTITY	COST($)	QUANTITY	COST($)
1.	Topsoil Stripping	- Roads	m^3	1.70	3,240	5,508	2,260	3,842
		- Lanes	m^3	1.70	1,880	3,196	nil	-
2.	Sub-Grade Preparation	- Roads	m^2	1.40	13,200	18,480	9,000	12,600
		- Lanes	m^2	1.40	7,030	9,842	nil	-
3.	Common Excavation	- Roads	m^3	4.25	1,900	8,075	1,500	6,375
		- Lanes	m^3	4.25	1,870	7,948	nil	-
4.	Excavation to Stockpile		m^3	5.50	3,410	18,755	1,960	10,780
5.	Screen and re-spread Topsoil		m^3	3.50	1,290	4,515	800	2,800
6.	Preparation and Seeding		m^2	0.50	8,550	4,275	5,300	2,650
7.	75 mm pit run gravel	- roads	tonne	7.00	5,540	38,780	3,780	26,460
		- lanes	tonne	7.00	2,960	20,720	nil	-
8.	19 mm crushed gravel	- roads	tonne	8.50	2,770	23,545	1,900	16,150
		- lanes	tonne	8.50	1,480	12,580	nil	-
9.	Prime Coat		m^2	0.40	13,200	5,280	9,000	3,600
10.	Tack Coat		m^2	0.30	26,400	7,920	18,000	5,400
11.	Asphaltic concrete (regular)		tonne	45.00	2,370	106,650	1,620	72,900
12.	Asphaltic Concrete (top lift)		tonne	52.00	790	41,080	540	28,080
13.	1.4 m monolithic sidewalk and curb		m	50.00	nil	-	780	39,000
14.	1.4 m sidewalk		m	38.00	2,130	80,940	nil	-
15.	250 mm curb and gutter		m	26.00	2,290	59,540	2,010	52,260
16.	Driveway Aprons		m^2	50.00	nil	-	860	43,000
17.	Laneway Aprons		m^2	50.00	70	3,500	nil	-
18.	50 mm watermain		m	90.00	nil	-	260	23,400
19.	150 mm watermain		m	98.00	1,195	117,110	790	77,420

TABLE 3.4 (Continued)

TABLE 3.4 (Continued)

	ITEM DESCRIPTION		UNIT	UNIT PRICE	TRADITIONAL		MODIFIED	
					QUANTITY	COST($)	QUANTITY	COST($)
20.	Hydrants		each	3,400.00	6	20,400	3	10,200
21.	Gate Valves:	- 50 mm	each	230.00	nil	-	4	920
		- 150 mm	each	400.00	10	4,000	5	2,000
22.	Fittings:	- 50 mm	each	200.00	nil	-	4	800
		- 150 mm	each	480.00	11	5,280	6	2,880
23.	Tapping saddle and corp. stop		each	120.00	120	14,400	140	16,800
24.	Curb stops		each	170.00	120	20,400	70	11,900
25.	19 mm service line		m	78.00	1,465	114,270	900	70,200
26.	25 mm service line		m	80.00	nil	-	380	30,400
27.	150 mm san sewer:	2 - 3 m depth	m	90.00	nil	-	250	22,500
		3 - 4 m depth	m	96.00	nil	-	790	75,840
28.	200 mm san. sewer:	2 - 3 m depth	m	95.00	200	19,000	nil	-
		3 - 4 m depth	m	101.00	1,040	105,040	nil	-
29.	Manholes:	2 - 3 m depth	each	1,500.00	1	1,500	1	1,500
		3 - 4 m depth	each	1,900.00	12	22,800	10	19,000
30.	100 mm service line		m	86.00	1,550	133,300	1,350	116,100
31.	100 mm x 100 mm x 100 mm WYE		each	35.00	nil	-	140	4,900
32.	100 mm cleanout and cap		each	80.00	nil	-	70	5,600
33.	300 mm storm sewer:	2 - 3 m depth	m	116.00	475	55,100	500	58,000
		3 - 4 m depth	m	122.00	155	18,910	nil	-
34.	250 mm catch basin leads		m	88.00	140	12,320	80	7,040
35.	Catch basins complete with grate		each	1,200.00	12	14,400	10	12,000
36.	Manholes:	2 - 3 m depth	each	1,500.00	3	4,500	3	4,500
		3 - 4 m depth	each	1,900.00	3	5,700	2	3,800
TOTAL						1,169,559		901,597



legend/notes

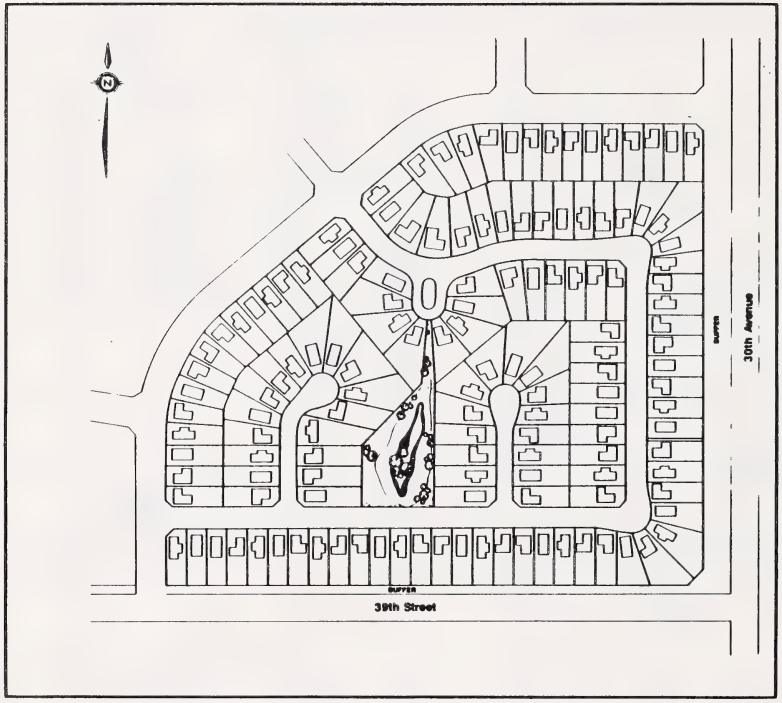
ROADS / STREETS	2.16 hac (16.0%)
LANES	1.25 hac (10.4%)
TOTAL	3.41 hac (28.4%)
BUFFERS	0.91 hac (7.6%)
PARK	0.20 hac (1.6%)
HOUSING	7.42 hac (61.8%)
NO. OF LOTS	120
AVERAGE LOT DIMENSION	10m x 30m
AVERAGE LOT AREA	618 m^2
GROSS DENSITY	10.0 UNITS/hac
NET DENSITY	16.2 UNITS/hac
GROSS SITE AREA	12.00 hac (100%)

Residential Subdivision Servicing
and
Design Practices

TRADITIONAL LAYOUT

DeLCan

DRAWING
1



legend/notes

ROADS : STREETS	1.56 hac (12.5%)
LANES	---
TOTAL	1.56 hac (12.5%)
BUFFERS	0.91 hac (7.5%)
PARK	0.41 hac (3.4%)
HOUSING	9.10 hac (76.6%)
NO. OF LOTS	140
AVERAGE LOT DIMENSION	16m x 42m
AVERAGE LOT AREA	650 m²
GROSS DENSITY	11.7 UNITS/hc
NET DENSITY	15.3 UNITS/hc
GROSS SITE AREA	12.00 hac (100%)

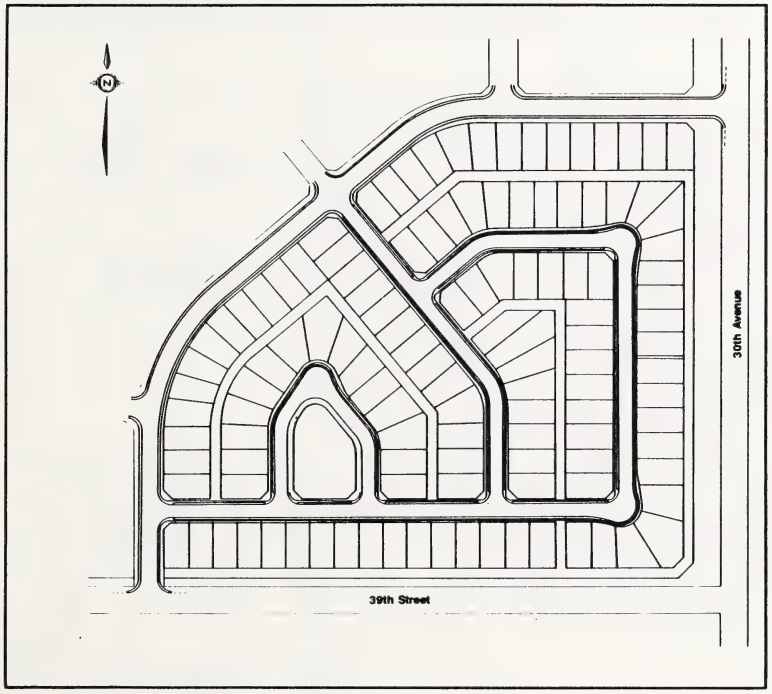
Residential Subdivision Servicing and Design Practices

MODIFIED LAYOUT

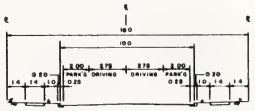
DeLCan

DRAWING **2**

20 0 20 40 60 80 100 120



legend/notes

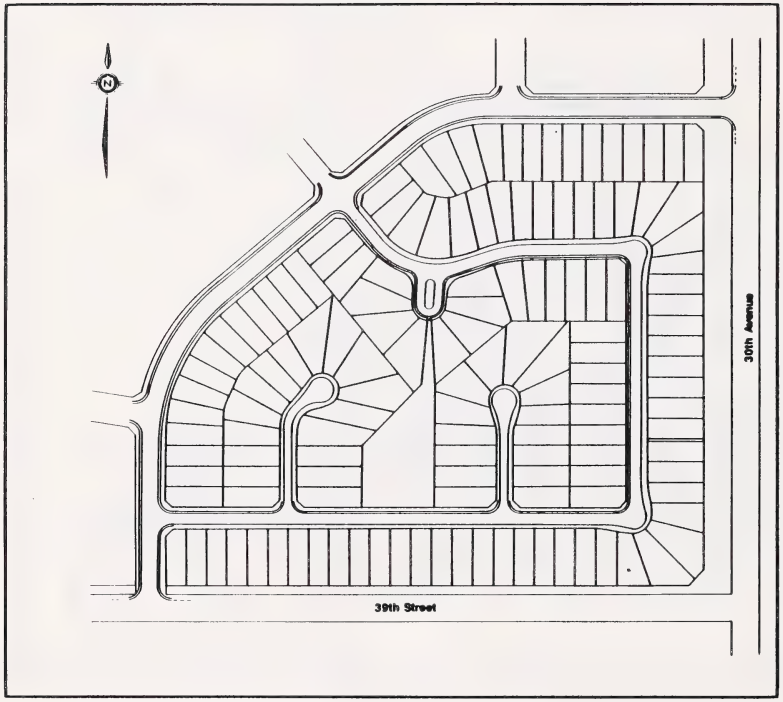


Residential Subdivision Servicing
and
Design Practices

TRADITIONAL ROADWAY STANDARDS

DeLCan

DRAWING
3



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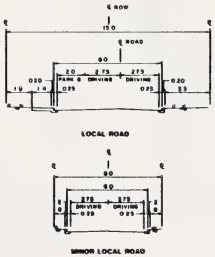
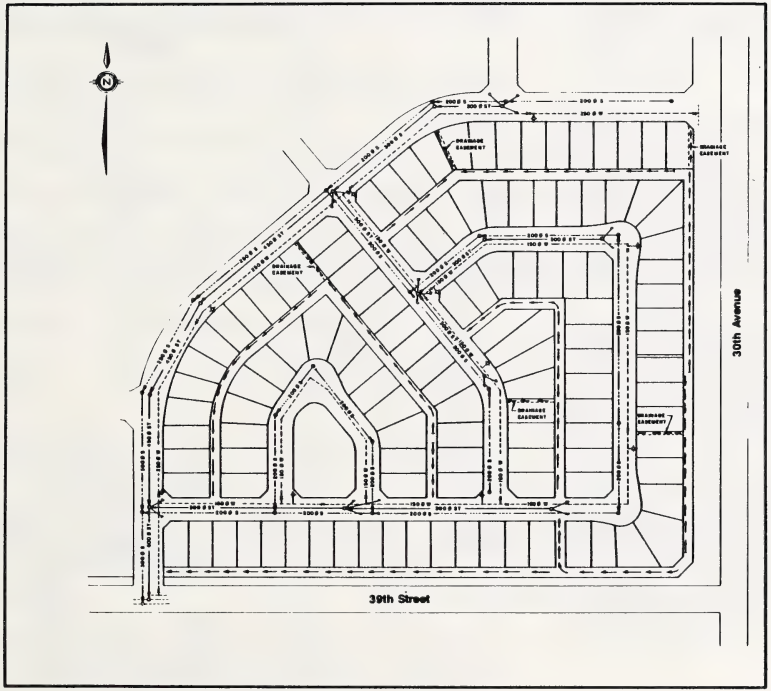


Residential Subdivision Servicing and Design Practices

MODIFIED ROADWAY STANDARDS

DeLCan

DRAWING **4**



legend/notes

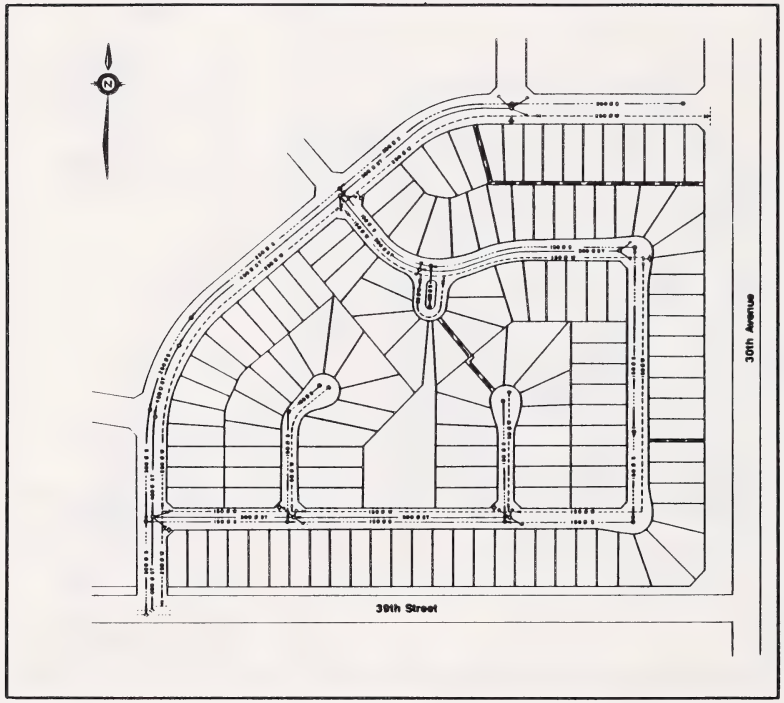
- 150mm DIA. WATERMAIN
- 200mm DIA. SANITARY SEWER
- SANITARY SEWER MANHOLE
- 300mm DIA. STORM SEWER
- STORM SEWER MANHOLE
- CATCH BASIN
- SURFACE DRAINAGE SWALE
- WATERMAIN GATE VALVE
- HYDRANT

Residential Subdivision Servicing and Design Practices

TRADITIONAL SERVICING STANDARDS

DelCan

DRAWING **5**



legend/notes

- 150mm DIA. WATERMAIN
- 200mm DIA. SANITARY SEWER
- SANITARY SEWER MANHOLE
- 300mm DIA. STORM SEWER
- STORM SEWER MANHOLE
- CATCH BASIN
- WATERMAIN GATE VALVE
- HYDRANT
- SURFACE DRAINAGE SWALE

Residential Subdivision Servicing and Design Practices

MODIFIED SERVICING STANDARDS

DeLCan

DRAWING **6**

4.0 ANALYSIS

For this analysis, one half of the total cost of the collector road and utilities is allocated to the subdivision cost. The collector road cost is estimated at $496,615; half of that is approximately $248,308.

Comparison of the two subdivision on a total cost basis is as follows:

Traditional: 248,308 + 1,169,559 = 1,417,867

Modified: 248,308 + 903,597 = 1,151,905

The total saving is $265,962, or approximately 19%. Expressed as a per lot cost, the savings are higher since the "Modified" subdivision yields more lots.

Traditional: 1,417,867/120 = $11,815/lot

Modified: 1,151,905/140 = $8,228/lot

This represents a total saving of $3,587 per lot, or approximately 30%.

In order to assess the areas where modifications yield the most significant savings, Table 3.5 on page 69, has been prepared for comparison of the two subdivisions. The costs used are sub-totals from items 1 to 36 in the previous section.

The most outstanding savings are achieved by the use of narrower rights-of-way, narrower pavement widths and elimination of lanes. This results in a saving of 43% of construction cost. Because the modified design also yields 20 additional lots, the saving is 51% of the per lot cost.

The saving effect of monolithic sidewalks on one side only in the "Modified" design is 6.8% in the construction cost, resulting in a 20% saving on a per lot cost basis.

The modifications proposed in the waterworks, sanitary sewer and storm sewer design all result in savings of approximately 20% of the construction cost and 30% when expressed as a cost per lot.

The use of "shared" water service connections result in a saving of 13% in construction cost, or 26% saving per lot. The use of "shared" sanitary sewer service connections resulted in only a 5% saving in construction cost, or 19% per lot. Further savings are possible if the water and sewer service connections are installed in the same trench, but for the sake of clarity this has not been included in this analysis.

Most noteworthy is the overall saving of approximately $3,500 per lot by applying the suggested design. In a stable and healthy market, all other things being equal, it should be theoretically possible to pass this saving on to the prospective home buyer.

It should also be noted that the changes to the appearance and serviceability of the subdivision in the "Modified" design are very subtle. Indeed the "Modified" version presents the same level of amenity in terms of park areas and lot areas, and no attempt has been made to increase density by use of multi-family housing. Spacing between homes is acceptable, front-yard setbacks are generous and rear yard space is maximized.

TABLE 3.5

SUMMARY OF COSTS

	ITEM	COST		SAVING		COST PER LOT		SAVING PER LOT	
		Traditional	Modified	$	%	Traditional	Modified	$	%
1.	Collector Road	248,308	248,308	-	-	2,069	1,774	295	14.3
2.	Internal Roadways (1 - 12)	337,149	191,637	145,512	43.2	2,810	1,369	1,441	51.3
3.	Sidewalks, Driveways (13 - 17)	143,980	134,260	9,720	6.8	1,200	959	241	20.0
4.	Watermains (18 - 22)	146,790	117,620	29,170	19.9	1,223	840	383	31.3
5.	Water Service Lines (23 - 26)	149,070	129,300	19,770	13.3	1,242	924	318	25.6
6.	Sanitary Sewers (27 - 29)	148,340	118,840	29,500	19.9	1,236	849	387	31.3
7.	San. Sewer Service Lines (30 - 32)	133,300	126,600	6,700	5.0	1,111	903	208	18.7
8.	Storm Sewers (33 - 36)	110,930	85,340	25,590	23.1	924	610	314	34.0
TOTALS		1,417,867	1,151,905	265,962	18.8	11,815	8,228	3,587	30.4

5.0 ANNUAL MAINTENANCE AND OPERATION COSTS

This section undertakes an evaluation of annual maintenance and operation costs of the various elements of municipal subdivision services. In order to obtain an order of magnitude of these costs, three municipalities were examined. The population ranges used as the criteria for selecting municipalities were 500,000 (large city), 50,000 (medium city) and 5,000 (medium town). The municipalities chosen were the City of Calgary, the City of Lethbridge and the Town of Olds respectively.

A questionnaire format* was used for soliciting cost information. Four major categories of subdivision services were used: Waterworks, Sanitary Sewers, Storm Sewers and Roadways. Each category was broken into measurable units such as kilometres of watermain, number of manholes, etc. The municipalities were then asked to estimate the percentage of the total unit cost attributable to various common maintenance procedures such as repairs, cleaning, thawing, etc.

An analysis was made of the responses in an attempt to quantify unit costs of annual maintenance and operation of each element. These average unit costs were then applied to the two subdivision designs referred to as the "Traditional" and "Modified", and the cost comparison made.

Finally, an appraisal was made of each of the items which involved some change from "Traditional" to "Modified", with respect to the effects these changes might have on annual maintenance and operation costs, and conclusions drawn.

* The questionnaire is shown in Appendix I in the Reference Manual.

6.0 SURVEY RESULTS

The first portion of the questionnaire dealt with a brief statement of current standards being used in the municipality. Although there were minor variations, it could be generalized that all of the three municipalities currently use standards that might be classified as "Traditional" when compared to the list in Table 3.1, on page 56.

Let us now examine the annual maintenance and operation costs of each major element by summarizing the cost data provided by each municipality.

6.1 Waterworks

A summary of the annual cost data is as follows:

	Calgary	Lethbridge	Olds
Watermain maintenance ($/km)	$3,650.00	$1,808.00	$2,200.00
House Service Lines ($/each)	20.00	12.93	13.50
Hydrants ($/each)	110.00	111.95	100.00

It should be noted that Calgary reported a high of $3,650/km water works maintenance.

The high cost of Calgary's watermain maintenance is due to corrosion repairs which are estimated as 52% of the total cost. Since this is strictly related to soils conditions and type of pipe material, the corrosion repair cost was deleted in the analysis. The annual cost of watermain maintenance for the City of Calgary, excluding corrosion repairs, is therefore 48% of $3,650, or $1,752.

One method of comparing the potential annual costs of the Traditional and Modified designs is to establish a

reasonable average unit cost for each element and apply this to the quantities in each design. The following were chosen as average unit annual costs:

Watermain maintenance:	$	2.00/m
House service connections:	$	10.00/each
Repair of curbstops:	$	5.00/each
Hydrant maintenance:	$	110.00/each

If these unit costs are applied to the two subdivision waterworks designs, we obtain the following comparison:

Traditional		Modified	
1195 m @ 2.00 =	$2,390.00	1050 m @ 2.00 =	$2,100.00
6 Hyd @ 110.00 =	660.00	3 Hyd @ 110.00 =	330.00
120 services @ 10.00 =	1,200.00	70 Services @ 10.00 =	700.00
120 curbstops @ 5.00 =	600.00	140 curbstops @ 5.00 =	700.00
Total	$4,850.00	Total	$3,830.00

It can be seen that the modified design demonstrates a potential saving of approximately $1,000 per year in overall waterworks maintenance. This conclusion is simplistic because it represents a direct extension of quantity and unit costs. In reality, the cost of maintenance will also be directly related to the quality of the original installation (i.e., the quality of pipe jointing, backfilling and compaction). Nevertheless, it would not be unreasonable to conclude from the comparison that, at the very least, no additional costs can be forecast with the Modified design. Indeed, if the quality of installation is ensured, potential savings in annual maintenance can accrue.

6.2 Sanitary Sewers

A summary of the annual cost data is as follows:

	Calgary	Lethbridge	Olds
Sanitary Sewer lines ($/km)	$1,250.00	$1,071.00	$1,400.00
Manholes ($/each)	7.50	6.79	6.80
House Service lines ($/each)	8.59	5.19	7.10

It is interesting to note that the annual costs of sanitary sewer and manhole maintenance are almost wholly attributable to cleaning and repair of breaks and leaks with little expenditure for blockages or freezing. On the other hand, the annual cost of house service line maintenance is almost wholly attributable to blockages.

Unit costs for each element have been averaged for the three communities and the following unit costs were chosen for comparison:

Sanitary sewer lines:	$1.30/m
Maholes:	$7.00/each
House service lines:	$7.00/each

If these unit costs are applied to the two subdivision sanitary sewer designs, we obtain the following comparison:

Traditional		Modified	
1240 m @ $1.30 =	$1,612.00	1040 m @ 1.30 =	$1,352.00
13 M.H. @ 7.00 =	91.00	11 M.H. @ 7.00 =	77.00
120 services @ 4.00 =	840.00	70 services @ 7.00 =	490.00
Total	$2,543.00	Total	$1,919.00

The comparison demonstrates a potential saving in annual costs with the Modified design. It should be pointed out that this occurs because the quantities are less. When one considers that in the responses to the questionnaire, over 60% of the costs of sewer line maintenance were due to repairs of breaks and leaks, it is obvious that quality of construction has the most significant effect on annual maintenance costs. The effects of using shared service connections will be discussed later.

6.3 Storm Sewers

A summary of the annual cost data is as follows:

	Calgary	Lethbridge	Olds
Storm sewer lines ($/km)	$ 454.00	$ 201.00	$ 275.00
Manholes/Catch Basins ($/each)	15.00	10.47	11.30

The average unit costs were selected as follows:

Storm sewer lines:	$ 0.30/m
Manholes/Catch Basins:	$12.00/each

Applying these unit costs to the two storm sewer designs yields the following comparison:

Traditional		Modified	
770 m @ 0.30 =	$ 231.00	580 m @ 0.30 =	$ 174.00
18 M.H. & C.B. @ 12.00 =	216.00	15 M.H. & C.B. @ 12.00 =	180.00
Total	$ 447.00	Total	$ 354.00

Again, it appears that lesser quantities of storm sewers and appurtenances would yield lower annual maintenance costs. In this instance, the larger portion of total costs is attributable to regular cleaning and de-icing procedures. When the Modified design uses proper overland routing techniques to prevent flooding damage, there is no reason for this design to incur any increase in annual maintenance costs.

6.4 Roadways

A summary of the annual cost data is as follows:

	Calgary	Lethbridge	Olds
Roadways ($/km)	$ 3,600	$ 2,235	$3,100.00
Laneways ($/km)	1,500	485	1,100.00
Sidewalks/Curbs ($/km)	400	25	120.00

For roadways, the responses indicate that less than 50% of the annual cost is attributable to maintenance such as sanding, sweeping and cleaning; 20% to pothole repairs; 20% to trench settlements; and 15% to surface repairs. The lower total cost for Lethbridge is attributed to less severe frost-heave problems.

For laneways, the entire cost of annual maintenance appears attributable to re-grading. Similarly for sidewalks and curb and gutter, 100% of the cost is due to repair of cracks and/or breaks.

The average annual costs per unit have been selected as follows:

Roadways:	$3.00/m
Laneways:	$1.00/m
Sidewalks/Curbs:	$0.20/m

Applying these average unit costs to the two subdivision designs, we obtain the following comparison:

Traditional		Modified	
Road: 950 m @ 3.00 =	$ 2,850	Road: 980 m @ $3.00 =	$ 2,940
Lanes: 1540 m @ $1.00=	1,540	Lanes: nil =	-
Sidewalk/curb:		Sidewalk/curb:	
2290 m @ 0.20 =	458	2010 m @ 0.20 =	402
Total	$ 4,848	Total	$ 3,342

It is evident that the Modified design demonstrates significantly lower annual maintenance costs than the Traditional design. This is due in large part to the elimination of lanes and the reduced quantity of sidewalk and curb. It can also be said that a narrower road surface will require less material for sanding, thereby further reducing costs. Approximately 35% of the costs of roadway maintenance are due to surface repairs and trench settlements. This can be reduced with improved quality of utility and roadway construction. Sanding and cleaning costs are directly related to the length of roadway. Elimination of lanes clearly reduces annual maintenance costs. Cracks and breaks in sidewalks and curb and gutter are inevitable because of traffic and ground movements. Increased efforts to design and construct base granular material in relation to local soil conditions can reduce these costs.

7.0 ANALYSIS

The foregoing summary of the survey results shows that savings in annual maintenance and operation costs can be achieved with the Modified subdivision design. For the most part, however, this occurs because there is generally less of everything in the Modified design and the application of average unit costs yields correspondingly lower total costs.

This type of comparison is simplistic in the sense that the only definite conclusion one can draw is that fewer items to maintain will result in less total cost.

In order to obtain a more realistic appreciation of the source of maintenance and operation costs, we should examine the proportion of costs which are attributable to regular maintenance procedures and those which are due to what might be termed "failure" of the element.

7.1 Waterworks

Examination of the survey results for waterworks distribution systems within a subdivision shows that only a small proportion of the total annual cost is due to regular maintenance procedures. On average regular maintenance procedures appear to account for 10 - 15% of the total costs, while 80 - 85% of these costs are due to repairs of "failures". The City of Calgary has a large

cost due to corrosion repairs because of inappropriate pipe materials in highly corrosive soils.

"Failures" in water distribution systems are generally caused by breaks and leaks in the underground network. These occurrences can be minimized through design by selection of appropriate pipe materials and adequate bedding and backfill for the pipe respecting local soils conditions.

They can also be minimized by quality control procedures during construction ensuring adequate placement and compaction of bedding material, proper jointing techniques, carefully compacted backfill and rigorous testing.

The suggestions which can achieve capital cost savings can be summarized as follows:

a) Allow smaller diameter watermains on short cul-de-sacs

b) Allow increased hydrant spacing

c) Allow increased valve spacing

d) Allow "shared" house service lines

When one examines these suggestions in the light of the source of the major part of the maintenance costs, i.e. "failures", it becomes evident that they have little or no effect on the annual costs. Indeed, if within a given area, there are less hydrants, valves etc. to repair, annual costs should be reduced.

"Shared" house service lines, with provision for a curbstop for each property, accessible within the road R.O.W. should not increase maintenance costs. Indeed, roadway trench settlements would be reduced and thawing of frozen services would also be reduced.

It is also evident that to reduce annual costs, efforts should be directed towards ensuring quality in the original design and installation in order to reduce the frequency of repairs of "failures". The combination of stressing quality of installation and allowing techniques for capital cost savings should have the net effect of reducing costs to the consumer, maintaining an acceptable level of service, and reducing annual operation and maintenance costs to the municipality.

7.2 Sanitary Sewers

Examination of the survey results on sanitary sewers shows that regular maintenance procedures such as cleaning and flushing accounts for approximately 40 - 50% of the total annual cost. The remaining 50 - 60% is due to repair of "failures" such as breaks and leaks.

As in the case of waterworks, the costs of repairs of breaks and leaks can be minimized by proper design and construction procedures suited to local soils conditions.

The suggested techniques for reduction of capital costs were, briefly stated:

a) Allow 150 mm sanitary sewers on dead-end runs.

b) Allow greater manhole spacing related to cleaning equipment available.

c) Allow curved sewers within acceptable curve limits.

d) Allow "shared" house service connections.

It has been argued that the use of 150 mm diameter pipe can lead to increased frequency of blockages and therefore higher cleaning costs. It has been conversely argued that a 150 mm diameter pipe laid at a steeper gradient than a 200 mm diameter pipe will induce greater flow velocities, especially when the pipe is flowing partially full.

Both arguments have validity. If a blockage occurs because of the intrusion of large objects, a larger pipe would cope better. If a blockage occurs because of low velocities causing sedimentation and subsequent build-up of particles, then a smaller pipe at a steeper gradient would be better suited. The recommendation is not that a 150 mm diameter pipe be used indiscriminately, but merely that the municipality allow its use where both the designer and the approving authority deem it appropriate.

Spacing of manholes and use of curved sewers should be related to the reach of a municipality's available cleaning and rodding equipment. Obviously, fewer manholes mean fewer repairs. Nevertheless, it will be impossible to clean sewers if manholes are spaced so far apart that the rodding equipment cannot reach parts of the line.

The idea of "shared" sewer house connnections has rarely been allowed in the belief that it would lead to increased frequency of blockages and potential disputes between the homeowners that share the service. However, if the "shared" portion of the pipe is kept within the right-of-way and a cleanout provided as suggested, these potential problems should be minimized. Theoretically, doubling the flow in this portion of the pipe should help rather than hinder to keep it clean and having a cleanout available in the road right-of-way will make it more convenient for municipal crews to remove blockages when they occur. Blockages in the individual property portion of the line should be no more frequent than normal.

7.3 Storm Sewers

The survey results on storm sewers indicate that, on average 70 - 75% of total annual costs are due to regular operation procedures such as cleaning, and thawing of frozen inlets. Repairs of breaks and leaks account for only 25 - 30% of the total costs. This may be because breaks and leaks in storm sewers are not as easily or quickly spotted as breaks in watermains or sanitary sewers. Further, the consequences of leaks are rarely disastrous and become evident only after considerable erosion has taken place.

Regular maintenance of storm sewers appears to be a more significant cost factor than repair of "failures" when compared with waterworks or sanitary sewers. This is not to say that proper design and construction procedures should not be followed. There are recorded cases where failure of a storm sewer pipe, subsequent leakage and erosion over time have incurred very high repair and rehabilitation costs.

The suggested techniques for reducing storm sewer capital costs can be summarized as follows:

a) Allow use of a 2-year return frequency storm for pipe design where there is adequate overland routing available.

b) Allow a minimum 250 mm diameter pipe.

c) Allow greater manhole spacing where equipment is available.

d) Allow greater catch basin spacing where roadway gradients are steeper.

e) Allow curved sewers within acceptable curve limits.

The use of a 2-year return frequency storm for pipe design is suggested only where adequate provision has been made in the subdivision design for overland routing of greater storms. This means that the overland route might be used more frequently than if a 5-year return frequency storm were used for the underground pipe design. Provided the overland route does not create any hazard or damage to people or property, there is no apparent reason for this method to lead to higher maintenance costs.

The allowance of curved sewers and greater manhole spacing should be related to the type of cleaning equipment available within the municipality.

Catch basin spacing should be specifically designed with respect to the capacity of the inlet grating, the capacity of the gutter being used and the street's longitudinal gradient. Therefore each street should be analyzed for these conditions and catch basin spacing computed accordingly.

7.4 Roadways

The survey results on roadway annual maintenance and operation costs indicate that approximately 50% of annual costs are attributable to regular maintenance procedures such as sanding, cleaning, snow removal, etc. and 50% are due to repairs of "failures" such as potholes, cracking and trench settlements.

Repair costs of "failures" can be minimized by proper design and construction of roadway sub-base, base and asphaltic pavement with careful attention paid to local soils conditions.

Maintenance of sidewalks and curb and gutter is almost wholly due to "failures". These are inevitable in Alberta's climate, but can be reduced by adapting design and construction to local conditions.

The cost of maintaining laneways is almost wholly attributable to re-gravelling and is inescapable. This cost might be reduced if laneways are paved but an inordinately high capital cost would be incurred.

The suggested techniques for capital cost savings in roadways can be summarized as follows:

a) Allow narrower rights-of-way for local roads.

b) Allow narrower pavement widths for local roads with no parking.

c) Allow an additional category which might be termed "minor local road" for culs-de-sac and small loops, with narrower rights-of-way and pavement widths.

d) Allow laneless subdivisions.

e) Allow monolithic sidewalk with curb and gutter on one side only for local roads.

f) Allow no sidewalk for "minor local roads".

The allowance of narrower rights-of-way and pavement widths for local roads and "minor local roads" should not incur any increase in maintenance costs if adequate space is provided for the installation and maintenance of utilities and there is adequate travelling space for vehicles. Parking is not recommended on these roads. Most municipalities do not clear snow on local roads. These suggestions save considerable capital cost and, within a given area, leave more land for lot development. As was stated, the cost of repairing "failures" is directly related to the design and quality of construction and would be no different in either case.

Elimination of laneways results in obvious savings in both capital construction costs and annual maintenance costs. It has been argued that construction of utilities in laneways results in less trench settlement in the roadways. This argument is valid since trench settlements in laneways occur but are of little consequence and are repaired each time re-gravelling takes place. In addition, compaction of backfill in laneway trenches need not be as stringent as compaction in roadways.

The survey indicates that repair of trench settlements in roadways accounts for 10 - 20% of the annual cost. If the average roadway annual cost is taken as $3,000/km, this could amount to $600/km. The average annual cost of laneway maintenance is approximately $1,000/km. Therefore, over the long term, the advantage of reducing trench settlement repair costs is outweighed by the elimination of lane maintenance costs. In terms of capital development costs, it would not be unreasonable to say that the value of land lost to lanes is generally greater than the cost of more stringent utility trench compaction and the cost of repairs to trench settlements during the warranty period. There are cases, of course, where soils conditions are so bad that it would be more prudent to install utilities in laneways. In many areas, market and historical preferences dictate the use of laneways.

·CONCLUSIONS·&·
·RECOMMENDATIONS·

CONCLUSIONS AND RECOMMENDATIONS

Municipalities must provide standards for subdivision design in order to ensure and maintain quality. Contrary to some opinions, these standards are not arbitrary and have evolved over time and experience.

Unfortunately the evolution appears to stop once the standards are published. Ironically this has tended to stifle innovation, since it becomes easier to comply than to argue for modification. It apppears that once rules are established, the rationale behind them are soon forgotten. For example, although many municipalities have newer cleaning equipment with larger reaches, manhole spacing requirements have not always changed.

Having gone through the analyses and discussions of the previous chapters, one conclusion is that it would be pointless to argue that municipalities should make wholesale changes to their standards. Rather, the message that becomes clear is that the evolution of standards should not stop at the publication stage. Standards should not be used as a replacement for continuing analysis and review.

Along with published standards, municipalities should provide an atmosphere that encourages appropriate innovation so that the development sector can come forward with new ideas. Innovation and cost efficiency is a dynamic and ongoing process and should not be held in check by inflexible standards. Proponents should be allowed to make a case for new ideas which should be assessed in the light of basic servicing principles and experience. If the case is sound, the idea should be accepted on its specific merits, not rejected out of hand because it does not conform to a current standard.

The objective of this report was to set down some of the basic principles in a logical and concise format for use in evaluating innovative ideas. It is by no means the end of the story. Indeed, the aim of this study was not merely to list new ideas. Rather it is hoped that the report can begin a regular process of assessment and renewal of innovation in the residential land development sector.

The best way to carry on this process is for municipal authorities take part in an ongoing information exchange. A good experience with an idea in one municipality should be passed on to others through a relatively simple mechanism. Journals and magazines achieve this to some extent but often not in a focussed manner.

The separate manual of assessment forms issued with this report provides a mechanism to begin a regular information exchange process. The booklet highlights the main information in the report and is designed to be commented upon and updated regularly. It starts with data collected from eight Alberta municipalities and will eventually include all Alberta municipalities by being updated yearly by Alberta Municipal Affairs with new information.

The booklet is not intended to be a manual of practice. It should be reviewed regularly and comments entered in the space provided. The comments can be processed, summarized and returned to the municipalities. In this fashion municipal officials can be kept abreast of the most recent developments in other areas of the Province and become involved in a regular and systematic exchange of ideas and information, with the overall aim of improving subdivision designs throughout the Province.

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